

**SAMPLING AND ANALYSIS PLAN
FOR
RED AND BONITA MINE
SILVERTON, SAN JUAN COUNTY, COLORADO**

Prepared for
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region 8

Prepared by
WESTON SOLUTIONS, INC.
Region 8 Superfund Technical Assessment and Response Team

September 5, 2014

For approval signatures, see Worksheet 1 & 2.

Project Dates of Sampling:	September 8-12, 2014
CERCLA ID / Site Spill Identifier No.:	NA/08UP
Contract Name:	START IV
Contract No.:	EP-S8-13-01
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List of Acronyms

AES	Atomic Emission Spectrometry
ARSG	Animas River Stakeholders Group
ASTM	American National Standards Institute
BLM	U.S. Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	Chain-of-Custody
COR	Contracting Officer Representative
CRQL	Contract Required Quantitation Limits
CSM	Conceptual Site Model
DRMS	Division of Reclamation Mining and Safety
EDD	electronic data deliverable
EPA	United States Environmental Protection Agency
ERRS	Emergency and Rapid Response Services
ERT	Environmental Response Team
ESAT	Environmental Services Assistance Team
GIS	Geographic Information System
GPM	gallons per minute
HASP	Health and Safety Plan
ICP	inductively coupled plasma/mass spectrometry
L	liter
LLCCV	low level continuing calibration verification
MDL	method detection limit
mL/L	milliliters per liter
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NaOH	sodium hydroxide
PPE	personal protective equipment
PSI	pounds per square inch
PT	proficiency testing
PTL	Project Team Lead
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
START IV	Superfund Technical Assessment and Response Team 4
TAL	Target Analyte List
TBD	to-be-determined
TCL	target compound list
TDD	Technical Direction Document
µg/L	micrograms per liter
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan
WAM	Work Assignment Manager
WESTON	Weston Solutions, Inc.
WQS	Water quality standard

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Introduction

This Sampling and Analysis Plan (SAP) identifies the data collection activities and associated quality assurance/quality control (QA/QC) measures specific to the Red and Bonita Mine (the Site) located in Silverton, San Juan County, Colorado. All data will be generated in accordance with the quality requirements described in the Quality Assurance Project Plan (QAPP) for Region 8 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Removal and Emergency Response Activities in Colorado, Utah, Wyoming, Montana, North Dakota, and South Dakota (Weston 2013). The purpose of this SAP is to describe site-specific tasks that will be performed in support of the stated objectives. This SAP will reference the QAPP for generic tasks common to all data collection activities including routine procedures for sampling and analysis, sample documentation, equipment decontamination, sample handling, data management, assessment, and data review. Additional site-specific procedures and/or modifications to procedures described in the QAPP are described in the following SAP elements.

This SAP is prepared, reviewed, and approved in accordance with the procedures detailed in the QAPP. Any deviations or modifications to the approved SAP will be documented using Table 1: SAP Revision Form. This SAP is produced in accordance with the Unified Federal Policy (UFP) for QAPPs and consists of the site-specific UFP Worksheets from the QAPP.

Refer to the QAPP Worksheet 3 & 5, and 4, 7, & 8 for an organizational chart, communication pathways, personnel responsibilities and qualifications, and special personnel training requirements.

QAPP Reference

Weston Solutions, Inc. 2013. Quality Assurance Project Plan for Region 8 CERCLA Removal and Emergency Response Activities in Colorado, Utah, Wyoming, Montana, North Dakota, and South Dakota. Prepared for the START IV Contract. July 2013.

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Worksheet 1 & 2 — Title and Approval Page

(UFP-QAPP Manual Section 2.1)
(EPA 2106-G-05 Section 2.2.1)

1. Project Identifying Information

- a) **Site Name/Project Name:** Red and Bonita Mine
- b) **Site Location/Number:** Silverton, San Juan County, Colorado
- c) **Contract/Work Assignment Number:** EP-S8-13-01/TDD 1306-07

2) List Plans and reports from previous investigation relevant to this project. Not Applicable

Lead Investigative Organization's SAP Author: Jan Christner/WESTON Senior Project Engineer
Printed Name/Title

Signature/Date

Lead Investigative Organization's Project Team Leader: Jan Christner/WESTON Senior Project Engineer
Printed Name/Title

Signature/Date

Lead Investigative Organization's Technical Manager: David Robinson/WESTON Response Coordinator
Printed Name/Title

Signature/Date

Federal Regulatory Agency OSC: Steven Way/OSC
Printed Name/Title

Signature/Date

Federal Regulatory Agency Delegated Approval Officer: _____
Printed Name/Title

Signature/Date

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Worksheet 9 — Project Planning Session Summary

(UFP-QAPP Manual Section 2.5.1 and Figures 9-12)
 (EPA 2106-G-05 Section 2.2.5)

Date of Planning Session: Various				
Location: Conference calls, meeting in warehouse 8/21/14				
Purpose: Develop test procedures for Red and Bonita packer test and support				
Name	Title/Role	Organization	Phone No.	E-mail Address
Steven Way	OSC	EPA	303-312-6723	Way.steven@epa.gov
Russ Nelson	Senior Scientist/ PTL	WESTON	720-505-7007	Russ.nelson@westonsolutions.com
Allen Sorenson	Scientist	DRMS	303-866-3567	Allen.sorenson@state.co.us

Notes/Comments: Meetings to plan packer test and water treatment.

Consensus Decisions Made:

- ☐ EPA's Emergency and Rapid Response Services (ERRs) contractor will provide pumps, water treatment supplies, and personnel to assist in water treatment and packer test system setup
- ☐ START will help operate the water treatment system, plan and procure equipment for the packer test, and perform a pre-test using the designed packer test equipment setup.
- ☐ WESTON/Russ Nelson, EPA/Steve Way, and DRMS/Allen Sorenson will work together to design, test, and implement the packer test.
- ☐ WESTON will prepare a sampling plan, perform water treatment system discharge field screening, collect water quality samples, document site activities, and provide on-site technical support as needed during the mine entries and water treatment.

Action Items:

Action	Responsible Party	Due Date
Develop SAP for sampling adit water and surface water associated with mine entries to be conducted the weeks of August 5 through 20	Jan Christner	September 5, 2014
Develop Health and Safety Plan	David Robinson	August 25, 2014
Develop conceptual design/schematic diagram for packer test system	Russ Nelson	August 15, 2014
Provide site documentation, field monitoring, sampling, and analysis.	Jeff Bryniarski, Elliott Petri, Eric Sandusky	September 8-12, 2014
Packer test implementation and documentation	Eric Sandusky	September 9, 2014
Prepare a Draft Site Activities Report	Jan Christner/Eric Sandusky	October 15, 2014 If sample laboratory analysis is required, the report will be delayed until November 20.
Prepare a Final Site Activities Report	Jan Christner/Eric Sandusky	October 30, 2014 or 2 weeks after EPA comments are received, whichever is later.

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Worksheet 10 — Conceptual Site Model

(UFP-QAPP Manual Section 2.5.2)

(EPA 2106-G-05 Section 2.2.5)

- **Problem Definition**

The Red and Bonita site consists of a mine adit and waste rock pile in the Cement Creek watershed. The mine discharges low pH, metals-laden water at a flow rate of approximately 300 gallons per minute (gpm). The water flows over a steep waste rock pile, passes through a culvert under a roadway, then flows toward Cement Creek, which discharges to the Animas River in Silverton, Colorado.

EPA and Colorado Division of Mining Reclamation and Safety (DRMS) will be entering the mine during September 2014 to characterize the properties of the mine a potential bulkhead location. The test will help determine if this location is structurally suitable for a bulkhead that may reduce the impacts to surface water from the mine discharges. During a previous mine entry, acid mine drainage and associated solids were discharged from the mine to the extent that it impacted downstream surface water quality; therefore, water will be captured, treated, then released downstream of the site during the 2014 mine investigation.

- **Background Information/Site History**

The Red and Bonita Mine is in the Cement Creek watershed, which originates high in the rugged San Juan Mountains of southwestern Colorado near the San Juan County and Ouray County line on the south slopes of Red Mountain Number 3 and the north slopes of Storm Peak.

The rugged and relatively inaccessible western San Juan Mountains were first prospected in the area around Silverton in 1860. The extension of the railroad from Silverton up Cement Creek to Gladstone in 1899 encouraged the mining of low grade ores, and the establishment of a lead-zinc flotation plant in 1917 allowed for the treatment of the low grade complex ores found in the area. Over a 100-year period between 1890 and 1991, mining activities in the upper Animas River Basin, including Cement Creek, produced the waste rock and mill tailings sources from which contamination spread throughout the surface water pathway. Over 18 million tons of ore were mined from the Upper Animas River Basin area, with more than 95 percent of this being dumped directly into the Animas River and its tributaries in the form of mill waste. Older waste rock piles and stope fillings were reworked and sent to mills as technology allowed lower grade ores to be processed economically. A great deal of abandoned waste was also milled during World War II when many older mining and milling structures were cannibalized for scrap metal. The last producing mine in the area was the Sunnyside Mine, which ceased production in 1991. The closing of the Sunnyside mine occurred after Lake Emma drained into the mine and out the American Tunnel into Cement Creek in 1978. The flood water from the Lake Emma “blow-out” was reported to have flowed down Cement Creek in a 10-foot wall of water that would have transported a large quantity of tailing and other mine waste down Cement Creek to the Animas River.

Reclamation activities have been ongoing in the Cement Creek basin since 1991 when tailings were removed from the Lead Carbonate Mill site. Remediation work has also been conducted in Gladstone at the American Tunnel waste dump, Mayflower Mill, Gold King #7 Level Mine, Galena Queen, Hercules Mine, Henrietta Mine, and most recently at the Joe and

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John Mine and the Lark Mine in 2006 and 2007. No new reclamation activities have been initiated in 2008 or 2009.

Numerous historic and now abandoned mines exist within a two-mile radius of Gladstone. They include: the Upper Gold King 7 Level, American Tunnel, Grand Mogul, Mogul, and Red and Bonita, Evelyne, Henrietta, Joe and John, and Lark mines. Some of these mines have acid mine drainage that flows between 30 and 300 gpm directly or indirectly into Cement Creek and eventually into the Animas River, the confluence located about eight miles downstream of Gladstone. The Animas River Stakeholders Group (ARSG), U.S. Bureau of Land Management (BLM), DRMS and private stakeholders have completed remediation projects at the Evelyne, Henrietta, Joe and John, and Lark mines.

The Red and Bonita Mine is the focus of this sampling effort. The site location is shown on Figure 1. Mine discharges and waste rock piles are the sources of waste at the Red and Bonita Mine. Contaminants are released via oxidation of pyrite within the mine and mine waste pile. Natural dissolution of metal contaminants also occurs in this mineral-rich watershed. Water that flows through the mine and the mine waste pile carries the contaminants to downstream locations via surface water. Water discharged from the site flows to Cement Creek and then to the Animas River, a fishery. Metals generated at the site that are transported via surface water may be attenuated in an adjacent bog and along the flow paths to Cement Creek and the Animas River. There are several additional mines in the area that are also sources of metals to Cement Creek.

Contaminants include low pH and metals. Cadmium concentrations from the mine discharge ranged from 33.3 micrograms per liter ($\mu\text{g/L}$) to 39.3 $\mu\text{g/L}$, copper concentrations ranged from 4.5 $\mu\text{g/L}$ to 50.6 $\mu\text{g/L}$, iron concentrations range from 76,700 $\mu\text{g/L}$ to 97,600 $\mu\text{g/L}$, lead concentrations ranged from 34 $\mu\text{g/L}$ to 71.2 $\mu\text{g/L}$, and zinc concentrations ranged from 13,600 $\mu\text{g/L}$ to 17,500 $\mu\text{g/L}$.

A mine entry was performed during 2012 to investigate the Red and Bonita Mine adit. During the mine entry, precipitates contained within the mine adit to a depth of 2 to 3 feet were disturbed and discharged from the adit, flowed down the tailings pile and along the pathway to Cement Creek, and discharged to Cement Creek. A trail of precipitates was left in the flow path. The disturbance likely caused a release of contaminants greater than would have been discharged had the mine remained undisturbed.

A mine entry was also conducted during the week of August 12, 2013. The mine entry was performed to fill data gaps regarding how and where water flows into the mine and where contaminants are generated within the mine. Water treatment, a sedimentation basin, and a filtration system were installed to reduce the potential for discharge of precipitates to Cement Creek during the mine entry.

This mine entry is being performed to determine the suitability of a potential bulkhead location. A packer/hydraulic conductivity test will be performed.

Background Reference: URS Operating Services, Inc. 2010. Red and Bonita Mine Remedial Action Field Sampling Plan. October 2010.

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Worksheet 11 — Project/Data Quality Objectives

(UFP-QAPP Manual Section 2.6.1)

(EPA 2106-G-05 Section 2.2.6)

1. State the Problem

EPA and DRMS will be entering the Red and Bonita Mine during September 2014 to determine the suitability of a potential bulkhead location. Due to the high particulates present in mine discharges during mine entries, water will be captured, treated, then released downstream of the site.

EPA has requested that WESTON assist in developing a packer test procedure, implementing the packer test, and developing and monitoring a water treatment system to increase the pH of adit discharge water and separate solids from the water prior to discharge from the site.

2. Identify the Goals of the Study

The goals of the study are to:

- Perform a packer/hydraulic conductivity test to help determine the suitability of the potential bulkhead location previously identified by EPA and DRMS
- Minimize discharges of particulates discharged from the Red and Bonita Mine during the mine entry.

The primary study questions are:

- What are the hydraulic properties of the rock at the potential bulkhead location?
- Were contaminants released from the site in excess of the amount that would have been discharged if the mine entry did not occur?
- What quantities of sodium hydroxide and flocculant are required to minimize particulate discharges from the Red and Bonita Mine site during the mine entry?
- What are disposal requirements for the generated solids?

3. Identify Information Inputs

To support the above objectives, the following data will be collected:

- Packer test procedures will be investigated and tested in the EPA warehouse.
- Packer test data will be collected as described in the Packer Test Procedure (Appendix B).
- Mine water will be collected in advance of the August mine entry and titrated to estimate the caustic and flocculant addition rates needed to minimize solids discharges.
- Treatment system influent and effluent and downstream waters will be visually

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monitored to document the efficiency of the treatment system. Field analysis may include pH, conductivity, temperature, dissolved oxygen, turbidity, and total suspended solids. The information will be used by EPA to confirm that the mine entry did not cause a significant increase in contaminant loading relative to normal discharges from the Red and Bonita Mine.

- SPLP analysis on generated solids. Potential treatability testing on solids (method to be determined).

4. Define the Boundaries of the Study

Spatial Boundaries: The study area includes the Red and Bonita Mine site (Figure 1), including the mine adit and water that flows from the site to Cement Creek.

Temporal Boundaries: The study will represent conditions immediately before, during, and immediately after the 2014 mine entry that is scheduled for September 8-12, 2014. A sampling schedule and sampling plan is included in Worksheets 14, 16 and 17.

Practical constraints on data collection: Scheduling adjustments will be made if physical constraints on planned field events occur due to weather, safety considerations, or problems that may impact the technical quality of the measurements.

5. Develop the Analytic Approach

A packer test will be performed in accordance with standard practice, as described in Appendix B. Data for each test will include radius of the hole, length of test section, depth from gauge to the upper surface of the packer, applied pressure at the gauge, steady flow (at 5 minute intervals), nominal diameter and length of intake hose between the gauge and packer, distance from the borehole surface to the terminus of the test section, and times of test initiation and measurements. The packer test will initially be performed at pressures of 60 pounds per square inch (psi), 80 psi, 100 psi, 80 psi, and 60 psi. The test range will be adjusted in the field, as needed.

A mine water sample will be used to estimate the amount of sodium hydroxide (NaOH) required to treat mine discharges to a pH of 6 to 7 during the mine entry. One sample is considered adequate because the data will only be used to estimate the amount of NaOH needed for procurement purposes. The actual amount of NaOH added during field water treatment will be adjusted based on field pH measurements of treated water. On-site testing will be performed to determine the optimum flocculant addition rate using Brennfloc, the flocculant supplied by EPA.

Solids will be collected to determine disposal requirements. Solids will be collected from within the mine and from water discharged to the settling pond. Samples will be submitted for TCLP analysis. Additional solids will be collected for in-house treatability testing to determine if addition of fly ash, Portland cement, or another chemical will improve solids handling characteristics (method to be determined prior to testing).

Field parameters will be measured periodically in water discharged from the site toward Cement Creek. It is not anticipated that water quality monitoring data will be directly compared to specific action levels or regulatory limits such as Colorado water quality standards (WQS) because the data is being collected to document the presence or absence of

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particulates in discharged water. If the OSC directs that samples be collected from site discharge water, Cement Creek, or the Animas River, the results may be compared to WQS for Animas River Stream Segment 3b (Animas River) or 7 (Cement Creek).

6. Specify Performance or Acceptance Criteria

Observations of the packer test will be performed to ensure there is not excessive water draining from the borehole, pressures are maintained for at least 3 minutes at each pressure, and that 90% recovery occurs during the recovery test.

Total and dissolved metals concentrations in the sampled solids and waters are expected to be high relative to the method detection limits, so standard laboratory reporting limits are considered adequate for the purposes of this data. All data will be reviewed and verified to ensure that they are acceptable for the intended use. Data will be validated at the request of the OSC.

Decision errors will be limited to the extent practicable by following approved U.S. EPA methods and applicable SOPs listed in Worksheet #21 and Appendix B. Any deviation from the SAP will be documented.

7. Develop the Detailed Plan for Obtaining Data

The detailed plan for the packer test is provided in Appendix B.

Water quality data will be obtained using a Horiba water quality meter. Field monitoring will be used to measure the quality of water discharged from the treatment system, with emphasis on pH and turbidity measurements. Visual observations of discharge water clarity will be recorded.

Solids will be collected by filtering water from the mine and from the inlet to the settling pond.

If an uncontrolled release of contaminated water and sediment occurs as indicated by the presence of orange stained precipitates in water leaving the site, water between the treatment system and the discharge to Cement Creek and/or other downstream locations may be sampled at the discretion of the OSC. If samples are collected, data from the laboratories will be delivered in an electronic data deliverable and reported in the Site Activities Report.

Worksheet 17 – Sample Design and Rationale, presents the sampling design, and QAPP Worksheets 19, 20, 24-28, and 30 specify analysis design requirements.

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Worksheet 14 & 16 —Project Tasks & Schedule
(UFP-QAPP Manual Section 2.8.2)
(EPA 2106-G-05 Section 2.2.4)

Activity	Responsible Party	Planned Start Date	Planned Completion Date	Deliverable(s)	Deliverable Due Date
Develop a Draft SAP and the EPA Region 8 QA Document Review Crosswalk	WESTON	July 31, 2014	September 5, 2014	Draft SAP and the Draft EPA Region 8 QA Document Review Crosswalk	September 5, 2014
Address EPA comments on Draft SAP and the Draft EPA Region 8 QA Document Review Crosswalk	WESTON	Upon receipt from EPA	1 week after receipt from EPA	SAP and the Final EPA Region 8 QA Document Review Crosswalk	1 week after receipt from EPA
Develop HASP	WESTON	August 2, 2014	August 8, 2014	HASP	August 8, 2014
Provide draft packer test schematic and procedure	WESTON	July 15, 2014	August 15, 2014	Technical Memo	August 15, 2014
Site work/Field Sampling	WESTON	September 8, 2014	September 12, 2014	NA	NA
Analytical Tasks*	ESAT	September 15, 2014	October 31, 2014	Laboratory Reports	To Weston TL: October 31, 2014 To EPA: with SAR
Quality Control Tasks*	WESTON	October 31, 2014	November 8, 2014	Report of Analyses/Data Package	To Weston TL: October 14, 2014 To EPA: with SAR
Draft Site Activities Report	WESTON	September 15, 2014	October 15, 2014	Draft Site Activities Report	October 15, 2014 If laboratory analysis is performed, the draft report will be provided on November 20, 2014
Address EPA comments on Draft Report	WESTON	October 14, 2014	October 30, 2014	Final Site Activities Report	October 30, 2014 or 2 weeks after EPA comments are received.

* If analysis is performed at the request of the OSC

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Worksheet 15 — Project Action Limits and Laboratory-Specific Detection/Quantitation Limits

(UFP-QAPP Manual Sections 2.6.2.3 and Figure 15)

(EPA 2106-G-05 Section 2.2.6)

The following information will be provided for each matrix, analyte, analytical method, and concentration level (if applicable).

Matrix: Water

Analytical Method: 200.7, 200.8

Concentration level (if applicable): Low to High

Analyte	PAL ¹	PAL Reference ¹	PQL Goal	Laboratory Quantitation Limit ²	Laboratory Detection Limit ²
NaOH titration	NA	NA	0.05 mL/L	0.05 mL/L	0.05 mL/L
TAL Metals – Total and Dissolved	NA	NA	CRQL	CRQL	CRQL
TCLP Metals	TCLP Limits	40 CFR 261.24	CRQL	CRQL	CRQL

¹ Links to State regulatory cleanup standards are provided in QAPP Appendix D.

² Terminology is project/laboratory-specific.

mL/L milliliters per liter

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Worksheet 17 — Sampling Design and Rationale

(UFP-QAPP Manual Section 3.1.1)

(EPA 2106-G-05 Section 2.3.1)

An initial mine water sample will be collected by stirring the mine pool water then dipping a container directly into the water, covered, and sent to START for a titration to estimate the sodium hydroxide addition rate needed to raise the pH of mine discharge water to 6 to 7 standard units. The initial pH of the water is expected to be between 2 and 4 standard units. The sample will be collected from just outside the portal to allow the sample to be collected safely, as proceeding into the mine would trigger additional health and safety requirements. Any uncertainty caused by collecting the sample from this location rather than from a “representative” location within the mine will be mitigated by the flexibility in the discharge pH (the range from 6 to 7 standard units) and the ability to adjust the NaOH addition rate during the water treatment process.

Treatment system discharges will be monitored for pH during operation of the treatment system, and other water quality parameters such as conductivity, TDS, and dissolved oxygen will be measured for as long as the additional information is helpful in determining whether the water treatment system is operating as intended. The target pH will be 6 to 7 standard units. Initially, properties will be measured at least every 15 minutes and reviewed hourly to confirm that the water treatment system is operating as intended. The discharge will be observed for the visible presence of solid precipitates at least hourly. The timing of measurements may be adjusted, as directed by the OSC, if conditions require more frequent measurements or if less frequent measurements are appropriate.

While it is not expected at this time, EPA may direct START to collect samples to characterize water quality impacts from site activities. Water samples for total metals analysis will be placed in a 1 liter (L) poly bottle and preserved with nitric acid to $\text{pH} \leq 2$. Water samples for dissolved metals analysis will be filtered with a $0.45 \mu\text{m}$ filter into a 1 L poly bottle and preserved with nitric acid to $\text{pH} \leq 2$. Samples will be placed in a n iced cooler. Solid/sediment samples will be collected from the mine and from water discharged into the settling pond and placed in a 5 gallon bucket.

Sample descriptions and monitoring data will be logged in the instrument and/or the field logbook. DRMS will provide physical descriptions and photographs, where practical, for test and sample locations within the mine, including distance from portal and other pertinent information.

Samples collected from outside the mine for total and dissolved metals analysis will be labeled RBSW##mmddyyyy-T and RBSW##mmddyyyy-D, where ## is the two digit sample number, with the first sample number being 01, and -T and -D indicate whether the sample is for total or dissolved metals analysis. Sediment samples will be labeled RBSE##mmddyyyy.

Sampling and analytical activities performed on site will follow all applicable SOPs outlined in Worksheet 21, including EPA ERT SOP 2001 “General Field Sampling Guidelines”. Sampling is anticipated to be performed in Level D personal protective equipment (PPE).

If collected, samples will be analyzed for the parameters listed in Table 2. In addition, requirements for the sample container, volume, preservation, and QC samples are presented in Table 2: Sampling and Analysis Summary.

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Worksheet 18 — Sampling Locations and Methods

(UFP-QAPP Manual Section 3.1.1 and 3.1.2)

(EPA 2106-G-05 Sections 2.3.1 and 2.3.2)

Sampling Location / ID	Matrix	Depth (units)	Type	Analyte/Analytical Group	Sampling SOP Reference ¹	Comments
Post-treatment samples at discharge from water treatment system and discharge to Cement Creek, if requested by EPA	Water	NA	Grab	Total and Dissolved Metals	2013	Grab sample collected by dipping container in water.
Pre-mobilization mine water sample	Water	NA	Grab	Titration	2013	Titration with 25% or 50% NaOH

¹ Sampling SOPs references will be provided in Worksheet 21.

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Worksheet 20 — Field Quality Control Sample Summary

(UFP-QAPP Manual Sections 3.1.1 and 3.1.2.)

(EPA 2106-G-05 Section 2.3.5)

Matrix	Analyte/Analytical Group	No. of Field Samples ¹	No. of Field Duplicates	No. of MS/MSD ²	No. of Field Blanks	No. of Equip. Blanks	No. of Trip Blanks	No. of Other	Total No. of Samples to Laboratory
Water	Total Metals	0	0	0	0	0	0	0	0
Water	Dissolved Metals	0	0	0	0	0	0	0	0
Water	Titration	1	0	0	0	0	0	0	1
Soil	Total Metals	0	0	0	0	0	0	0	0
Soil	Dissolved Metals	0	0	0	0	0	0	0	0
Soil	TCLP Metals	2	0	0	0	0	0	0	2

¹ Samples that are collected at different depths at the same location, and analyzed separately, will be counted as separate field samples. Even if they are taken from the same container as the parent field sample, MS/MSDs are counted separately, because they are analyzed separately. If composite samples or incremental samples are collected, only the sample that will be analyzed will be included; subsamples and increments will not be listed separately.

² Total number of samples to the laboratory does not include MS/MSD samples.

Note: If EPA requests that field samples be collected and analyzed for total and dissolved metals, the need for a duplicate will be determined based on the rationale for sampling. The number and types of QC samples will be based on project-specific DQOs and this worksheet will be adapted, as necessary, to accommodate project-specific requirements. Project-specific QC samples may include field duplicate, field blank, equipment blank, trip blank, field split, MS/MSD, and PT samples and will be collected in accordance with the frequencies recorded on QAPP Worksheet 12.

Quality Assurance Assessment and Corrective Actions are found in QAPP Worksheet #28.

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Worksheet 21 — Field SOPs
 (UFP-QAPP Manual Section 3.1.2)
 (EPA 2106-G-05 Section 2.3.2)

SOP Number or Reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP Option or Equipment Type (if SOP provides different options)	Modified for Project? Y/N	Comments
2006	Sampling Equipment Decontamination, 6/2011	U.S. EPA, ERT	NA	N	SOPs are available in Appendix B
2013	Surface Water Sampling, 6/2011	U.S. EPA, ERT	NA	N	SOPs are available in Appendix B
G-12	Specifications and Guidance for Contaminant-Free Sample Containers, 12/1992	U.S. EPA, Office of Solid Waste and Emergency Response	NA	N	SOPs are available in Appendix B
2001	General Field Sampling Guidelines, 6/2011	U.S. EPA, ERT	NA	N	SOPs are available in Appendix B
2016	Sediment Sampling, 6/2011	U.S. EPA, ERT	NA	Y	SOPs are available in Appendix B
NA	Packer Test Procedure	Weston Solutions	NA	N	See Appendix B

For purposes of this SAP, investigation-derived wastes (IDW) are defined as any byproduct of the field activities that is suspected or known to be contaminated with hazardous substances. The performance of field activities will produce waste products, including spent sampling supplies (disposable scoops) and expendable PPE. IDW will also include soil cuttings and decontamination fluids.

IDW will be managed in accordance with EPA Guide to Management of Investigation Derived Wastes (EPA 1992). Spent sampling supplies and expendable PPE are not anticipated to be considered a hazardous and will be containerized and disposed of in the municipal waste system. Soil cuttings will be returned to the boring or spread around the boring as soon as possible after generation and sampling is complete. Decontamination water will be poured onto the ground close to the boring from which the soil was collected.

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Worksheet 22 — Field Equipment Calibration, Maintenance, Testing, and Inspection
 (UFP-QAPP Manual Section 3.1.2.4)
 (EPA 2106-G-05 Section 2.3.6)

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title or Position of Responsible Person	Verification	SOP Reference ¹
GPS	Calibrate tape against calibrated steel measuring tape	Clean prior and after each use, check battery	Calibration and operational equipment check	Visually inspect for obvious defects, broken parts, or cleanliness	Prior to use	Equipment operational	Repair/replace as needed	Field personnel	WAM/COR	Instrument-Specific
Horiba U-50/YSI® 600XLM Water Quality Meters	Calibrate probes with standards per instrument instruction manual	Check batteries, clean probes, store in manufacturer recommended solution	Calibration check	Visually inspect for external damage to probe(s)	Refer to instrument SOP	Refer to instrument SOP	Refer to instrument SOP	Field personnel	WAM/COR	G-13/G-14

¹ Refer to Field SOPs (Worksheet 21) and Analytical SOPs (Worksheet 23).

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Worksheet 23 — Analytical SOPs

(UFP-QAPP Manual Section 3.2.1)

(EPA 2106-G-05 Section 2.3.4)

Lab SOP Number ¹	Title, Revision Date, and/or Number and URL (if available)	Screening or Definitive Data	Matrix/Analytical Group	SOP Option or Equipment Type	Modified for Project? (Y/N)
TBD	METHOD 6010C INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROMETRY (ICP-AES), 11/2000, http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/6010c.pdf	Definitive	Water/Soil	ICP-AES	TBD
TBD	METHOD 6020A INDUCTIVELY COUPLED PLASMA-MASS SPECTROMETRY (ICP-MS), 2/2007, http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/6020a.pdf	Definitive	Water/Soil	ICP-MS	TBD

¹ Lab SOP numbers are lab-specific.

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Worksheet 24 — Analytical Instrument Calibration

(UFP-QAPP Manual Section 3.2.2)

(EPA 2106-G-05 Section 2.3.6)

As stated in Worksheet 22, START field personnel are responsible for the calibration of START and sub-contractor provided analytical field equipment. Documented and approved procedures will be used for calibrating measuring and testing equipment. Widely accepted procedures, such as those published by U.S. EPA and American National Standards Institute (ANSI), or procedures provided by manufacturers in equipment manuals will be adopted.

The responsibility for the calibration of laboratory equipment rests with the selected laboratories. Each type of instrumentation and each U.S. EPA-approved method have specific requirements for the calibration procedures, depending on the analytes of interest and the sample medium. The calibration procedures and frequencies of the equipment used to perform the analyses will be in accordance with requirements established by the U.S. EPA. The laboratory QA manager will be responsible for ensuring that the laboratory instrumentation is maintained in accordance with specifications. Individual laboratory SOPs will be followed for corrective actions and preventative maintenance frequencies. Laboratory quality control, calibration procedures, corrective action procedures, and instrument preventative maintenance will be included in an addendum to this QAPP once the laboratories have been selected for each sites. Items may include, but are not limited to those identified in the table below.

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Worksheet 24 — Analytical Instrument Calibration (Continued)

(UFP-QAPP Manual Section 3.2.2)

(EPA 2106-G-05 Section 2.3.6)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for CA	SOP Reference ¹
ICP-AES	See 6010C	Calibration and initial calibration verification after instrument set up, then daily; continuing calibration verifications. Upper range within 10%. New upper range limits should be determined whenever a significant change in instrument response or every six months. Low-level continuing calibration verification (LLCCV) standard with 30%.	Initial and continuing calibration verification within $\pm 10\%$ of upper range true values and $\pm 30\%$ LLCCV true values.	Inspect system; correct problem; re-run calibration and affected samples	Lab Manager/Analyst	6010C
ICP/ ICP-MS	See 6010C, 6020A, ISM01.3	Calibration and initial calibration verification after instrument set up, then daily; continuing calibration verification 10% or every 2 hours, whichever is more frequent	Calibration $r^2 > 0.995$; initial and continuing calibration verification within $\pm 20\%$ of true values	Inspect system; correct problem; re-run calibration and affected samples	Lab Manager/Analyst	6010C, 6020A, ISM01.3

¹ Refer to the Analytical SOPs table (Worksheet 23).

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Worksheet 26 & 27 — Sample Handling, Custody, and Disposal

(UFP-QAPP Manual Section 3.3)

(EPA 2106-G-05 Manual Section 2.3.3)

Examples of field form (QAPP Appendix F), chain-of-custody (QAPP Appendix G), and sample label and custody seal (QAPP Appendix H) documentation are attached. SOPs for sample handling (identified in the table below) are located in QAPP Appendix I.

Sampling Organization: WESTON

Laboratory (Titration): Accutest, 4036 Youngfield Street, Wheat Ridge, CO 80033, Shea G, 303-425-6021, 303-425-6854

Laboratory (Total and dissolved metals): EPA Region 8 Laboratory, ESAT, 16194 West 45th Drive, Golden, CO 80033, Don Goodrich, Goodrich.donald@epa.gov, 303-312-6687; Mark McDaniel, mcdaniel.mark@epa.gov.

Note –The OSC will review and approve the SAP prior to proceeding with lab procurement. Therefore additional information will not be available until the lab procurement has been finalized.

Method of sample delivery (shipper/carrier): Hand delivered or FedEx

Number of days from reporting until sample disposal: 180

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP Reference
Sample Labeling	WESTON Field Personnel	SOP G-1 & G-3
Chain-of-Custody Form Completion	WESTON Field Personnel	SOP G-8
Sample Packaging	WESTON Field Personnel	SOP G-9
Shipping Coordination	WESTON Field Personnel	SOP G-9
Sample Receipt, Inspection, & Log-in	Laboratory Sample Custodian	Laboratory SOP
Sample Custody and Storage	Laboratory Sample Custodian/Laboratory Analytical Personnel	Laboratory SOP
Sample Disposal	Field Personnel/Laboratory Sample Custodian /Laboratory Analytical Personnel	SOP G-1 & G-3/ Laboratory SOP

Supplies and consumables can be received at a WESTON office, U.S. EPA Warehouse or at a site. When supplies are received at a WESTON office or U.S. EPA Warehouse, the PM or PTL will sort the supplies according to vendor, check packing slips against purchase orders, and inspect the condition of all supplies before the supplies are accepted for use on a project. If the supplies do not meet the acceptance criteria, deficiencies will be noted on the packing slip and purchase order. The item will then be returned to the vendor for replacement or repair.

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Worksheet 26 & 27 — Sample Handling, Custody, and Disposal (Continued)

(UFP-QAPP Manual Section 3.3)

(EPA 2106-G-05 Manual Section 2.3.3)

Procedures for receiving supplies and consumables in the field are similar to those described above. Upon receipt, items will be inspected by the WESTON PM or PTL against the acceptance criteria. Any deficiencies or problems will be noted in the field logbook, and deficient items will be returned for immediate replacement.

Laboratory Data Deliverables						
Record	VOCs	SVOCs	PCBs	Pesticides	Metals	Other
Narrative					X	
COC					X	
Summary Results					X	
QC Results					X	
Chromatograms						
Tentatively Identified Compounds						

Data collection activities, including sample collection and data generation, will be verified in accordance with the START IV Program QAPP, Worksheet #35.

Data will be validated by WESTON START.

Data will be reviewed for usability in accordance with the START IV Program QAPP, Worksheet #37.

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TABLES

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Table 1
SAP Revision Form

Site: Red and Bonita Mine
OSC: Steven Way
TDD: 1306-07

Date	Revision Number	Proposed Change to SAP/QAPP	Reason for Change of Scope/Procedures	SAP Section Superseded	Requested By	Approved By
9/5/14	1	Add sediment sampling, packer testing	Change in project Scope	All	Steven Way	

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Table 2
Sampling and Analysis Summary

Site: Red and Bonita Mine
OSC: Steven Way
TDD: 1306-07

Matrix	Analytical Parameter	Analytical Method	Containers (Numbers, Size, and Type)	Preservation Requirements	Number of Sampling Locations	Number of Field Duplicates	Number of MS/MSDs ²	Number of Blanks (Trip, Field, Equip. Rinsate) ¹	Total Number of Samples to Lab ³	Holding Time
Water	Total Metals	200.7, 200.8	One 1-L poly bottle	Nitric acid to pH<2	0*	1 per 10	1 per 10	0	11	6 months
Water	Dissolved Metals	200.7, 200.8	One 1-L poly bottle	Filtered then preserved with nitric acid to pH≤2	0	1 per 10	1 per 10	0	11	6 months
Water	Titration	NA	1 1-gallon bucket	None	1	0	0	0	0	1 week
Sediment	TCLP, Disposal evaluation	1311, 6010,6020	1 5 gallon bucket	None	2	0	0	0	2	6 months

Notes:

¹ Trip blanks are only required for VOCs in water samples.

² For the samples designated for MS/MSDs, triple volume is required for VOCs and double volume for other water parameters.

³ Total number of samples to the laboratory does not include MS/MSD samples.

* Samples will be collected only if requested by the OSC.

°C – Degrees Celsius

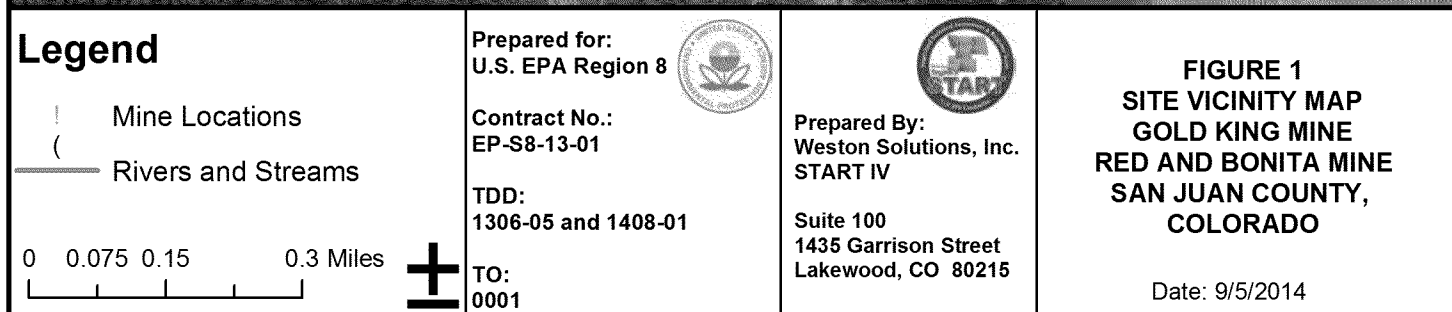
Equip. – Equipment

MS/MSD – Matrix Spike/Matrix Spike Duplicate

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FIGURES



ATTACHMENTS

Appendix A
EPA Region 8 QA Document Review Crosswalk

EPA REGION 8 QA DOCUMENT REVIEW CROSSWALK

QAPP/FSP/SAP for: (check appropriate box)	Entity (grantee, contract, EPA AO, EPA Program, Other)	Regulatory Authority	<input type="checkbox"/> 40 CFR 31 for Grants <input type="checkbox"/> 48 CFR Part 46 for Contracts <input type="checkbox"/> Interagency Agreement <input type="checkbox"/> EPA Administrative Order <input type="checkbox"/> EPA Program Funding <input type="checkbox"/> EPA Program Regulation <input type="checkbox"/> EPA CIO 2105
<input type="checkbox"/> GRANTEE	EPA – Emergency Response	and/or	
<input type="checkbox"/> CONTRACTOR			
<input checked="" type="checkbox"/> EPA			
<input type="checkbox"/> Other		Funding Mechanism	
Document Title [Note: Title will be repeated in Header]	Red & Bonita Mine Sampling and Analysis Plan		
QAPP/FSP/SAP Preparer	Weston Solutions, Inc.		
Period of Performance (of QAPP/FSP/SAP)	1 year from date of EPA approval of Task Level QAPP	Date Submitted for Review	September 5, 2014
EPA Project Officer EPA Project Manager	Joyce Ackerman Steven Way	PO Phone # PM Phone #	303-312-6822 303-312-6723
QA Program Reviewer or Approving Official		Date of Review	

Documents to Review:

- QAPP written by Grantee or EPA must also include for review:
Work Plan(WP) / Statement of Work (SOW) / Program Plan (PP) / Research Proposal (RP)
- QAPP written by Contractor must also include for review:
 - Copy of signed QARF for Task Order
 - Copy of Task Order SOW
 - Made available hard or electronic copy of approved QMP
 - If QMP not approved, provide Contract SOW
- For a Field Sampling Plan (FSP) or Sampling & Analyses Plan (SAP), the Project QAPP must also be provided.
OR
The FSP or SAP must be clearly identified as a stand-alone QA document and must contain all QAPP required elements (Project Management, Data Generation/Acquisition, Assessment and Oversight, and Data Validation and Usability).

Documents Submitted for QAPP Review:**1. QA Document(s) submitted for review:**

QA Document	Document Date	Document Stand-alone	Document with QAPP
QAPP	07/31/13	Yes / No	
FSP		Yes / No	Yes / No
SAP	09/5/14	Yes / No	Yes / No
SOP(s)			Yes / No

2. WP/SOW/TO/PP/RP Date EP-S8-13-01**WP/SOW/TO/RP Performance Period** 12/30/14**3. QA document consistent with the:**WP/SOW/PP for grants? Yes / NoSOW/TO for contracts? Yes / No**4. QARF signed by R8 QAM** Yes / No / NA**Funding Mechanism** IA / contract / grant / NA**Amount** _____**Summary of Comments** (highlight significant concerns/issues):

- Comment #1
- Comment #2
- Comment #3
- The EPA – Emergency Response must address the comments in the Summary of Comments, as well as those identified in the Comment section(s) that includes a

Red & Bonita Mine Sampling and Analysis Plan

"Response (date)" and Resolved (date)".			
Element	Acceptable Yes/No/NA	Page/ Section	Comments
A. Project Management			
A1. Title and Approval Sheet			
a. Contains project title	Y	Title Page and Introduction Worksheet 1 & 2	
b. Date and revision number line (for when needed)	Y	Title Page and Revision Log	
c. Indicates organizations name	Y	Title Page	
d. Date and signature line for organizations project manager	Y	Worksheets 1 & 2, 4, 7 & 8	
e. Date and signature line for organizations QA manager	Y		
f. Other date and signatures lines, as needed	Y	Worksheets 1 & 2, 4, 7 & 8	
A2. Table of Contents			
a. Lists QA Project Plan information sections	Y	Table of Contents, List of Appendices	
b. Document control information indicated	Y	Worksheet 1 & 2, Revision Log	
A3. Distribution List			
Includes all individuals who are to receive a copy of the QA Project Plan and identifies their organization	Y	Worksheet 3 & 5	
A4. Project/Task Organization			
a. Identifies key individuals involved in all major aspects of the project, including contractors	Y	Worksheet 3 & 5, 6, 4, 7, & 8	
b. Discusses their responsibilities	Y	Worksheet 4, 7 & 8, 6	
c. Project QA Manager position indicates independence from unit generating data	Y	Worksheet 3 & 5, 4, 7 & 8	
d. Identifies individual responsible for maintaining the official, approved QA Project Plan	Y	Worksheet 4, 7 & 8, Revision Log	
e. Organizational chart shows lines of authority and reporting responsibilities	Y	Worksheet 3 & 5	
A5. Problem Definition/Background			
a. States decision(s) to be made, actions to be taken, or outcomes expected from the information to be obtained	Y	Worksheet 11	
b. Clearly explains the reason (site background or historical context) for initiating this project	Y	Worksheet 10	
c. Identifies regulatory information, applicable criteria, action limits, etc. necessary to the project	Y	Worksheets 11, 15	

Red & Bonita Mine Sampling and Analysis Plan

A6. Project/Task Description			
a. Summarizes work to be performed, for example, measurements to be made, data files to be obtained, etc., that support the projects goals	Y	Worksheets 11, 14 & 16	
b. Provides work schedule indicating critical project points, e.g., start and completion dates for activities such as sampling, analysis, data or file reviews, and assessments	Y		
c. Details geographical locations to be studied, including maps where possible	Y	Worksheets 10, 11	
d. Discusses resource and time constraints, if applicable	Y		
A7. Quality Objectives and Criteria			
a. Identifies - performance/measurement criteria for all information to be collected and acceptance criteria for information obtained from previous studies, - including project action limits and laboratory detection limits and - range of anticipated concentrations of each parameter of interest	Y	Worksheets 12.1 & 12.2	
b. Discusses precision	Y	Worksheets 12, 36, 37	
c. Addresses bias	Y		
d. Discusses representativeness	Y		
e. Identifies the need for completeness	Y		
f. Describes the need for comparability	Y		
g. Discusses desired method sensitivity	Y		
A8. Special Training/Certifications			
a. Identifies any project personnel specialized training or certifications	Y	Worksheet 4, 7 & 8	
b. Discusses how this training will be provided	Y		
c. Indicates personnel responsible for assuring training/certifications are satisfied	Y		
d. identifies where this information is documented	Y		
A9. Documentation and Records			
a. Identifies report format and summarizes all data report package information	Y	Worksheets 14 & 16, 29	Data reporting only. No report requested.

Red & Bonita Mine Sampling and Analysis Plan

b. Lists all other project documents, records, and electronic files that will be produced	Y	Worksheet 14 & 16	
c. Identifies where project information should be kept and for how long	Y	Worksheet 29	
d. Discusses back up plans for records stored electronically	Y		
e. States how individuals identified in A3 will receive the most current copy of the approved QA Project Plan, identifying the individual responsible for this	Y	Worksheet 4, 7 & 8	
B. Data Generation/Acquisition			
B1. Sampling Process Design (Experimental Design)			
a. Describes and justifies design strategy, indicating size of the area, volume, or time period to be represented by a sample	Y	Worksheet 11, 17	
b. Details the type and total number of sample types/matrix or test runs/trials expected and needed	Y	Worksheets 17, 18	Unknown number of samples
c. Indicates where samples should be taken, how sites will be identified/located	Y		
d. Discusses what to do if sampling sites become inaccessible	Y	Worksheet 17	
e. Identifies project activity schedules such as each sampling event, times samples should be sent to the laboratory, etc.	Y	Worksheets 14 & 16	Schedules may change due to the nature of emergency response.
f. Specifies what information is critical and what is for informational purposes only	Y	Worksheet 17	
g. Identifies sources of variability and how this variability should be reconciled with project information	Y	Worksheet 17	
B2. Sampling Methods			
a. Identifies all sampling SOPs by number, date, and regulatory citation, indicating sampling options or modifications to be taken	Y	Worksheet 21	
b. Indicates how each sample/matrix type should be collected	Y	Worksheet 19 & 30	
c. If in situ monitoring, indicates how instruments should be deployed and operated to avoid contamination and ensure maintenance of proper data	Y	Worksheet 22	

Red & Bonita Mine Sampling and Analysis Plan

d. If continuous monitoring, indicates averaging time and how instruments should store and maintain raw data, or data averages	NA	Worksheet 22	
e. Indicates how samples are to be homogenized, composited, split, or filtered, if needed	Y	Worksheet 21	If needed
f. Indicates what sample containers and sample volumes should be used	Y	Worksheet 19 & 30	
g. Identifies whether samples should be preserved and indicates methods that should be followed	Y		
h. Indicates whether sampling equipment and samplers should be cleaned and/or decontaminated, identifying how this should be done and by-products disposed of	Y	Worksheet 21	If needed
i. Identifies any equipment and support facilities needed	Y	Worksheet 22	
j. Addresses actions to be taken when problems occur, identifying individual(s) responsible for corrective action and how this should be documented	Y	Worksheets 17, 31, 32 & 33	
B3. Sample Handling and Custody			
a. States maximum holding times allowed from sample collection to extraction and/or analysis for each sample type and, for in-situ or continuous monitoring, the maximum time before retrieval of information	Y	Worksheet 19 & 30	
b. Identifies how samples or information should be physically handled, transported, and then received and held in the laboratory or office (including temperature upon receipt)	Y	Worksheet 26 & 27	
c. Indicates how sample or information handling and custody information should be documented, such as in field notebooks and forms, identifying individual responsible	Y		
d. Discusses system for identifying samples, for example, numbering system, sample tags and labels, and attaches forms to the plan	Y		
e. Identifies chain-of-custody procedures and includes form to track custody	Y		
B4. Analytical Methods			

Red & Bonita Mine Sampling and Analysis Plan

a. Identifies all analytical SOPs (field, laboratory and/or office) that should be followed by number, date, and regulatory citation, indicating options or modifications to be taken, such as sub-sampling and extraction procedures	Y	Worksheet 23	
b. Identifies equipment or instrumentation needed	Y	Worksheets 23, 24	
c. Specifies any specific method performance criteria	Y	Worksheet 24	
d. Identifies procedures to follow when failures occur, identifying individual responsible for corrective action and appropriate documentation	Y		
e. Identifies sample disposal procedures	Y	Worksheet 26 & 27	
f. Specifies laboratory turnaround times needed	Y	Worksheet 19 & 30	
g. Provides method validation information and SOPs for nonstandard methods	Y	Worksheets 23, 36	
B5. Quality Control			
a. For each type of sampling, analysis, or measurement technique, identifies QC activities which should be used, for example, blanks, spikes, duplicates, etc., and at what frequency	Y	Worksheet 20	
b. Details what should be done when control limits are exceeded, and how effectiveness of control actions will be determined and documented	Y	Worksheet 28 - Identifies general criteria. Actual inputs determined on a project-specific basis	
c. Identifies procedures and formulas for calculating applicable QC statistics, for example, for precision, bias, outliers and missing data	Y	Worksheet 37	
B6. Instrument/Equipment Testing, Inspection, and Maintenance			
a. Identifies field and laboratory equipment needing periodic maintenance, and the schedule for this	Y	Worksheets 22, 24	
b. Identifies testing criteria	Y		
c. Notes availability and location of spare parts	Y		
d. Indicates procedures in place for inspecting equipment before usage	Y	Worksheets 22, 24	
e. Identifies individual(s) responsible for testing, inspection and maintenance	Y		
f. Indicates how deficiencies found should be resolved, re-inspections performed, and effectiveness of corrective action determined and documented	Y	Worksheets 22, 24	
B7. Instrument/Equipment Calibration and Frequency			

Red & Bonita Mine Sampling and Analysis Plan

a. Identifies equipment, tools, and instruments that should be calibrated and the frequency for this calibration	Y	Worksheet 25	
b. Describes how calibrations should be performed and documented, indicating test criteria and standards or certified equipment	Y	Worksheet 25	
c. Identifies how deficiencies should be resolved and documented	Y		
B8. Inspection/Acceptance for Supplies and Consumables			
a. Identifies critical supplies and consumables for field and laboratory, noting supply source, acceptance criteria, and procedures for tracking, storing and retrieving these materials	Y	Worksheet 26 & 27	
b. Identifies the individual(s) responsible for this	Y		
B9. Use of Existing Data (Non-direct Measurements)			
a. Identifies data sources, for example, computer databases or literature files, or models that should be accessed and used	Y	Worksheet 13	
b. Describes the intended use of this information and the rationale for their selection, i.e., its relevance to project	Y		
c. Indicates the acceptance criteria for these data sources and/or models	Y		
d. Identifies key resources/support facilities needed	Y		
e. Describes how limits to validity and operating conditions should be determined, for example, internal checks of the program and Beta testing	Y		
B10. Data Management			
a. Describes data management scheme from field to final use and storage	Y	Worksheets 11, 26 & 27, 29, 35	
b. Discusses standard record-keeping and tracking practices, and the document control system or cites other written documentation such as SOPs	Y	Worksheets 26 & 27, 29	
c. Identifies data handling equipment/procedures that should be used to process, compile, analyze, and transmit data reliably and accurately	Y	Worksheets 22, 23, 29	
d. Identifies individual(s) responsible for this	Y	Worksheet 29	
e. Describes the process for data archival and retrieval	Y		

Red & Bonita Mine Sampling and Analysis Plan

f. Describes procedures to demonstrate acceptability of hardware and software configurations	Y	Worksheets 22, 23	
g. Attaches checklists and forms that should be used	Y		
C. Assessment and Oversight			
C1. Assessments and Response Actions			
a. Lists the number, frequency, and type of assessment activities that should be conducted, with the approximate dates	Y	Worksheet 31, 32 & 33	
b. Identifies individual(s) responsible for conducting assessments, indicating their authority to issue stop work orders, and any other possible participants in the assessment process	Y		
c. Describes how and to whom assessment information should be reported	Y		
d. Identifies how corrective actions should be addressed and by whom, and how they should be verified and documented	Y		
C2. Reports to Management			
a. Identifies what project QA status reports are needed and how frequently	Y	Worksheet 31, 32 & 33	
b. Identifies who should write these reports and who should receive this information	Y		
D. Data Validation and Usability			
D1. Data Review, Verification, and Validation			
Describes criteria that should be used for accepting, rejecting, or qualifying project data	Y	Worksheet 36	
D2. Verification and Validation Methods			
a. Describes process for data verification and validation, providing SOPs and indicating what data validation software should be used, if any	Y	Worksheets 34, 35, 36	
b. Identifies who is responsible for verifying and validating different components of the project data/information, for example, chain-of-custody forms, receipt logs, calibration information, etc.	Y	Worksheet 35	
c. Identifies issue resolution process, and method and individual responsible for conveying these results to data users	Y	Worksheets 35, 36	

Red & Bonita Mine Sampling and Analysis Plan

d. Attaches checklists, forms, and calculations	Y	Worksheet 34	
D3. Reconciliation with User Requirements			
a. Describes procedures to evaluate the uncertainty of the validated data	Y	Worksheets 11, 12, 35, 36	
b. Describes how limitations on data use should be reported to the data users	Y	Worksheet 36	

Appendix B Selected Standard Operating Procedures



START 4 - REGION 8 TECHNICAL MEMORANDUM

TO: Steve Way, EPA Region 8 On-Scene Coordinator

FROM: Russ Nelson, Superfund Technical Assessment and Response Team (START4)
Eric Sandusky, Superfund Technical Assessment and Response Team (START4)

DATE: June 23, 2014
August 27, 2014 (rev 1)

SUBJECT: Red & Bonita Insitu Permeability Packer Test, Silverton, San Juan County, Colorado.

The United States Environmental Protection Agency (EPA) tasked the Weston Solutions, Inc., (WESTON) Superfund Technical Assessment and Response Team 4 (START4) under Technical Direction Document (TDD) #0001-1306-05 to support U.S. EPA's efforts at the Red & Bonita Mine site in Silverton, San Juan County, Colorado (Site). This memo describes a suggested procedure and equipment needs for performing a packer test to evaluate the in situ hydraulic permeability of the shallow rock in the Red & Bonita mine wall. The results of the test may be used to determine where a bulkhead may be constructed to control or eliminate the flow of acidic water emanating from the mine.

In Situ Permeability Tests Using a Single Packer

There are two single packer test procedures which can be effectively utilized to evaluate hydraulic permeability, cumulative and concurrent. Both tests involve drilling a borehole into the mine wall, inserting and setting a packer element, injecting water between the packer element and the borehole terminus, and measuring the flow of water required to maintain a given pressure. Cumulative tests are performed after the borehole has been drilled to the full depth and concurrent tests are performed at iterative depths as the borehole is drilled. Both use the terminus of the borehole as the lower (deeper) boundary of the test interval and the packer element as the upper (shallower) boundary of the test interval. Both have advantages and disadvantages.

Cumulative Test

For a cumulative packer test, the hole is drilled to the full depth (expected to be approximately ten feet for the Red & Bonita test) and then flushed with clean water. Failing to adequately clean the hole may result in a permeable rock appearing to be impermeable because the borehole wall

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is sealed by cuttings or sediment. The packer element is inserted a pre-determined distance into the hole and the packer gland is inflated with nitrogen in order to seal the element against the borehole wall. Water is injected under pressure into the void between the packer element and the terminus of the borehole while flow rates and pressures are recorded. The test is repeated over a series of increasing then decreasing pressures. The packer is deflated and lifted up a pre-determined distance to the next testing interval and the test is repeated until the entire length of the hole is tested.

With a cumulative test, the test intervals are a series of overlapping zones rather than discrete lengths, and resulting data must be mathematically processed to determine unique permeability values and remove the overlap effect. The major limitation to this approach is that zones of higher permeability at depth can mask the permeability determinations for the shallower zones. A positive aspect of a cumulative test is that it requires less standby time than a concurrent test.

Concurrent Test

A concurrent test can also be performed using a single packer element. A test is conducted as the borehole is drilled in a series of discrete intervals and tested at each interval. Generally, a concurrent test can be accomplished relatively quickly with an experienced packer testing crew.

The hole is drilled to a pre-determined depth and flushed with clean water. The testing interval is bounded by the packer element and the terminus of the borehole which can be as shallow as three to six feet deep. The packer element is inserted and the gland is inflated with nitrogen in order to seal the element against the borehole wall. Water is injected under pressure into the void between the packer element and the terminus of the borehole while flow rates and pressures are recorded. The packer is deflated and removed, and then drilling to the next test interval commences. The packer is inserted deeper into the borehole to test the next interval once the drill has been removed and the borehole flushed with clean water. This process is repeated until the entire length of the borehole is drilled and tested. Limitations to this method include the need to test immediately after drilling a targeted test interval, which requires the packer testing team to standby while drilling takes place and the driller to standby while the packer test team works.

Pressurization and Flow Measurements

Regardless of the chosen test procedure, similar steps are taken to collect the test data. Once the packer element is inserted and inflated and the borehole is injected with water, observations of water injection flow rates are made every minute until three consecutive, consistent readings are taken to represent steady-state flow. The pressure is then increased incrementally then decreased at the same increments. It is common practice to ramp up over 3 to 5 increasing pressures and to ramp back down two to four steps using the same pressure steps. This is done to test for hysteresis in the plotted data. The steady-state flow at each pressure is recorded. To begin the test, the tester will need to have an idea of the pressures to be tested (these are referred to as

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pressure steps A, B, and C below). The expected pressure range will be based on the estimated permeability of the rock and the expected intake of injected water. If insufficient pressure is used for Pressure A, the test can be extended to include additional pressure steps. If Pressure A is excessive, the test can be stopped and restarted at a lower initial pressure. Data is plotted on a flow rate vs. pressure graph.

Pressure Step	Test Pressure (psi)
A	60
B	80
C	100
B(r)	80
A(r)	60

r = recovery or descending pressure

Borehole Orientation

The orientation of the borehole relative to the fractures significantly affects the number of fractures intercepted by the hole and the perceived permeability. A vertical hole drilled in a material that has predominantly vertical fractures such as flat-bedded sediments will not intercept the predominant control on the rock mass permeability. The drill holes should be oriented to cross as many fractures as possible not only for more meaningful permeability tests, but also to get meaningful rock mass design parameters.

Test Depth Intervals and Pressures

Typically, the test interval may be 10 feet (3 m) long, but the water can be going into one ¼-inch (8-mm) fracture. Test intervals greater than 20 feet (6 m) are inadvisable because, typically, there are a few fractures or a relatively small zone that controls the groundwater flow in bedrock. The calculated permeability of the packer test interval may be a magnitude different from the actual rock mass permeability. Only in the case of a highly fractured rock mass is the calculated permeability relatively reliable and the result is still a relative or effective permeability.

The pressure used in testing should be based on the rock being tested. Relatively flat-lying, bedded rock should be tested at 0.5 lbs/in² per foot (0.1 kg/cm²/m) of test interval to prevent uplift or jacking of the rock. Relatively homogeneous but fractured rock can be tested at 1 lb/in² per foot (0.2 kg/cm²/m) of test interval depth. Relatively un-fractured rock can be tested at 1.5 lb/in² per foot (0.3kg/cm²/m) of test interval depth. The proposed borehole diameter will be approximately 2 inches with a maximum depth of approximately 10 feet. Based on these dimensions, each test is expected to use approximately 32 to 35 gallons of water per packer test excluding the volume of clean out water.

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Data Collection

Data required for computing the permeability may not be available until the hole has encountered relatively impermeable strata. The required data for each test includes:

- Radius, r , of the hole, in centimeters
- Length of test section, the distance between the packer and the terminus of the borehole
- Depth, h_1 ,
 - Concurrent test = from pressure gauge to the terminus of the borehole,
 - Cumulative test = from gauge to the upper surface of the packer
- Applied pressure, h_2 , at the gauge, in feet (meters)
- Steady flow, Q , into well at 5-minute intervals, in cubic feet per second (ft³/sec) (cubic meters per second [m³/sec]).
- Nominal diameter in inches (mm) and length of intake hose in feet (m) between the gauge and packer.
- Distance D , from the ground surface to the terminus of the test section, in feet (m).
- Time that the test is started and the time measurements are made.

Recommended Test Equipment and Arrangement

The recommended arrangement of test equipment starting at the source of water is: source of water; suction line; centrifugal or positive displacement pump; line to water meter inlet pipe; water meter; short length of pipe; valve; waterline to swivel; gauge; and hose to packer (Attachment B). All connections should be kept as short and straight as possible, and the number of changes in hose diameter, pipe, etc., should be kept as small as possible. All joints, connections, and hose between the water meter and the packer or casing should be tight, and there should be no water leaks.

The following equipment is needed:

- Appropriate sized single packer unit (w/ 1 backup unit)
- Spare sized glands (2) to fit test packers
- Spare o-rings for unit
- Top supply tube for packer assembly
- Hose couplings for connecting packer assembly (with spares)
- 25 mm disk type water flow meter capable of 1 to 50 gpm, with an instantaneous flow indicator and a totalizer
- Centrifugal pump (electric or gas) with minimum flow rate of at least 50 gpm up to 200 psi
- Require minimum of 2 spares for all glands, gauges, regulators, and meters
- Regulator and all lines and fittings, capable of reading and maintaining 50 gpm or 200 psi discharge pressure respectively
- Composite inflation line

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- Lighting

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Attachment A

Test Procedure

A total of 5 tests will be run at each interval at each borehole. Starting pressure will be 60 psi, increasing to 80 psi and 100psi, then back down to 80 psi and finally 60 psi. Problems with the packer system will be indicated by excessive water draining from the borehole, the packer removing itself from the borehole, this indicates that the water pressure in the borehole is overcoming the friction caused by the gland of the packer, the air pressure is insufficient. Isolated tests will be run prior to testing to insure the packer system is functioning properly. Calculations will be done by START or DRMS, and a determination of suitability will be given by DRMS.

1. Prepare packer assembly: single packer with open bottom;
2. Check inflation line connecting the packer and fittings – do not over tighten as you might strip the threads;
3. Check packer assembly for any leakage. Inflate to maximum gland working pressure in appropriate length and diameter of drill hole;
4. Prepare and check water feeding system: tank, supply, pump (centrifugal or positive displacement w/min 50 gpm and min discharge pressure of 200 psi) , connection hoses, pressure gauges (the ideal location for a pressure gauge is in the test section, but as close to the packer as possible), valves and flow-meter;
5. Drill hole preparation: removal of drilling mud and cuttings (flush with clear water);
6. Insert single packer assembly to pre-determined depth in bore hole end of drill hole
7. Inflate packer slowly (by 50 psi steps) until working pressure has been reached.
8. This will require filling to working pressure plus calculated hydrostatic pressure;
9. After inflation is complete, monitor packer inflation line pressure for a minimum of 2 minutes to see if system is leaking. If no leaks apparent, then;
10. Attach water feed system;
11. Note: a shut-in test can be carried out during the pressure stabilization (this will be described below);
12. Check inflation lines and inflation pressure to ensure no leaks occur, check water feeding system, prepare stop-watch and field test form;
13. Packer system is now ready for testing.
14. Open water feeding system valve and maintain constant initial pressure A until it appears to have stabilized (often about 10-15 minutes);
15. During this time, record the elapsed time and total volume of consumed water every ½ min or so, for the first 2-3 min of the test stage, then every minute;
16. After pressure A has stabilized for approximately 3 minutes, increase the pressure to pressure B;
17. Record time vs. flow rate as for A

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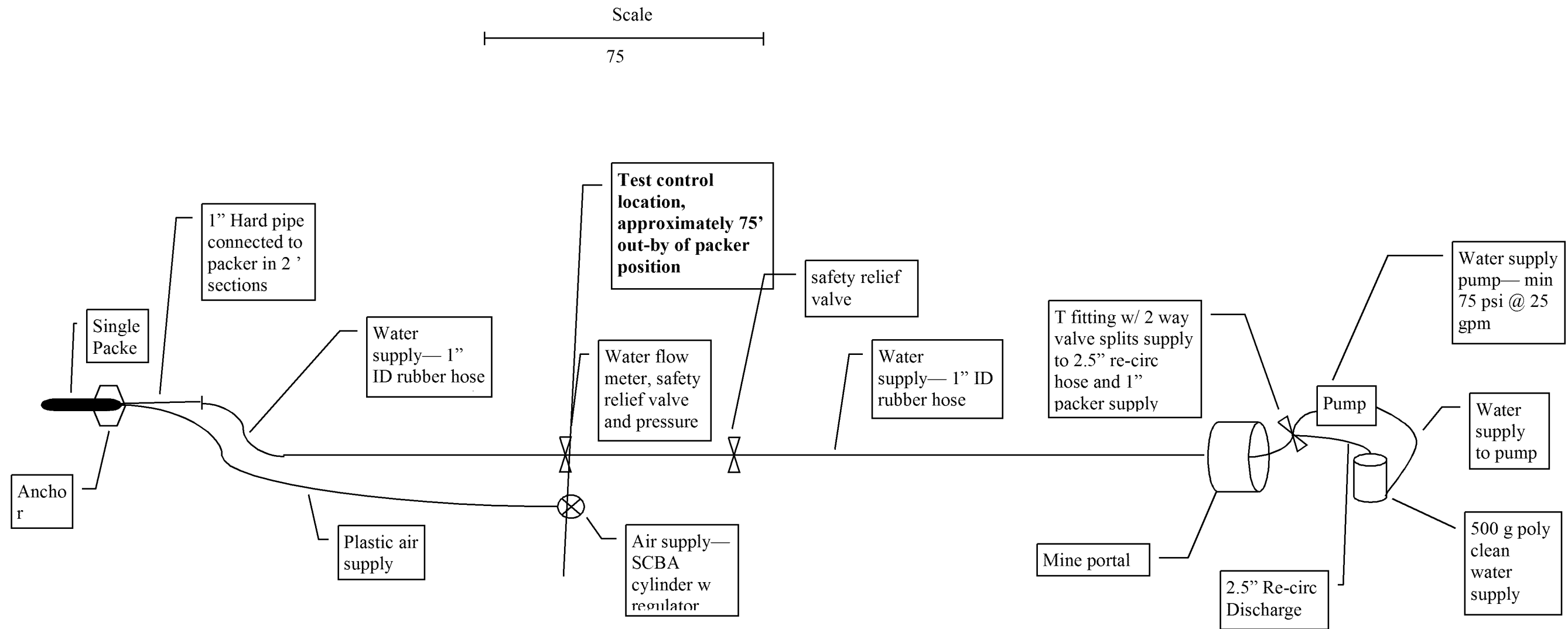
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18. Increase the pressure, after pressure B has stabilized for approximately 3 minutes, to pressure C;
19. Repeat pressure stage B (or last ascending pressure, D or C, if more than 3 steps used in test) – if formation is tight, release pressure by bypass valve on water feeding system to decrease pressure from C to B quickly;
20. Repeat pressure stage A – if formation is tight, release pressure by bypass valve on water feeding system to decrease pressure from B to A quickly;
21. After repeating stage A, perform recovery test: shut the feed valve and record pressure decrease vs. time for about 10-15 min, or until 90% recovery has occurred;
22. Deflate packer assembly and remove stuffing box cap and seal;
23. Wait until all nitrogen escapes from the packer cells, wait an additional 5 minutes and then pull the assembly carefully to top of drill rods, watching for the marker flag to prevent pulling assembly into overhead sheave.

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Attachment B



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GENERAL FIELD SAMPLING GUIDELINES

SOP#: 2001
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide general field sampling guidelines that will assist REAC personnel in choosing sampling strategies, location, and frequency for proper assessment of site characteristics. This SOP is applicable to all field activities that involve sampling.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling is the selection of a representative portion of a larger population, universe, or body. Through examination of a sample, the characteristics of the larger body from which the sample was drawn can be inferred. In this manner, sampling can be a valuable tool for determining the presence, type, and extent of contamination by hazardous substances in the environment.

The primary objective of all sampling activities is to characterize a hazardous waste site accurately so that its impact on human health and the environment can be properly evaluated. It is only through sampling and analysis that site hazards can be measured and the job of cleanup and restoration can be accomplished effectively with minimal risk. The sampling itself must be conducted so that every sample collected retains its original physical form and chemical composition. In this way, sample integrity is insured, quality assurance standards are maintained, and the sample can accurately represent the larger body of

material under investigation.

The extent to which valid inferences can be drawn from a sample depends on the degree to which the sampling effort conforms to the project's objectives. For example, as few as one sample may produce adequate, technically valid data to address the project's objectives. Meeting the project's objectives requires thorough planning of sampling activities, and implementation of the most appropriate sampling and analytical procedures. These issues will be discussed in this procedure.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected, and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest. Sample preservation, containers, handling, and storage for air and waste samples are discussed in the specific SOPs for air and waste sampling techniques.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The nature of the object or materials being sampled may be a potential problem to the sampler. If a material is homogeneous, it will generally have a uniform composition throughout. In this case, any sample increment can be considered representative of the material. On the other hand, heterogeneous samples present problems to the sampler because of changes in the material over distance, both laterally and vertically.

Samples of hazardous materials may pose a safety threat to both field and laboratory personnel. Proper health and safety precautions should be implemented when handling this type of sample.

Environmental conditions, weather conditions, or non-target chemicals may cause problems and/or interferences when performing sampling activities or when sampling for a specific parameter. Refer to the specific SOPs for sampling techniques.

5.0 EQUIPMENT/APPARATUS

The equipment/apparatus required to collect samples must be determined on a site specific basis. Due to the wide variety of sampling equipment available, refer to the specific SOPs for sampling techniques which include lists of the equipment/apparatus required for sampling.

6.0 REAGENTS

Reagents may be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed. Decontamination solutions are specified in ERT SOP #2006, Sampling Equipment Decontamination.

7.0 PROCEDURE

7.1 Types of Samples

In relation to the media to be sampled, two basic types of samples can be considered: the environmental sample and the hazardous sample.

Environmental samples are those collected from streams, ponds, lakes, wells, and are off-site samples that are not expected to be contaminated with hazardous materials. They usually do not require the special handling procedures typically used for concentrated wastes. However, in certain instances, environmental samples can contain elevated concentrations of pollutants and in such cases would have to be handled as hazardous samples.

Hazardous or concentrated samples are those collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated, and require special handling procedures because of their potential toxicity or hazard. These samples can be further subdivided based on their degree of hazard; however, care should be taken when handling and shipping any wastes believed to be concentrated regardless of the degree.

The importance of making the distinction between environmental and hazardous samples is two-fold:

- (1) Personnel safety requirements: Any sample thought to contain enough hazardous materials to pose a safety threat should be designated as hazardous and handled in a manner which ensures the safety of both field and laboratory personnel.
- (2) Transportation requirements: Hazardous samples must be packaged, labeled, and shipped according to the International Air Transport Association (IATA) Dangerous Goods Regulations or Department of Transportation (DOT) regulations and U.S. EPA guidelines.

7.2 Sample Collection Techniques

In general, two basic types of sample collection techniques are recognized, both of which can be used for either environmental or hazardous samples.

Grab Samples

A grab sample is defined as a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once at one particular point in the sample medium. The representativeness of such samples is defined by the nature of the materials being sampled. In general, as sources vary over time and distance, the representativeness of grab samples will decrease.

Composite Samples

Composites are nondiscrete samples composed of more than one specific aliquot collected at various sampling locations and/or different points in time. Analysis of this type of sample produces an average value and can in certain instances be used as an alternative to analyzing a number of individual grab samples and calculating an average value. It should be noted, however, that compositing can mask problems by diluting isolated concentrations of some hazardous compounds below detection limits.

Compositing is often used for environmental samples and may be used for hazardous samples under certain conditions. For example, compositing of hazardous waste is often performed after compatibility tests have

been completed to determine an average value over a number of different locations (group of drums). This procedure generates data that can be useful by providing an average concentration within a number of units, can serve to keep analytical costs down, and can provide information useful to transporters and waste disposal operations.

For sampling situations involving hazardous wastes, grab sampling techniques are generally preferred because grab sampling minimizes the amount of time sampling personnel must be in contact with the wastes, reduces risks associated with compositing unknowns, and eliminates chemical changes that might occur due to compositing.

7.3 Types of Sampling Strategies

The number of samples that should be collected and analyzed depends on the objective of the investigation. There are three basic sampling strategies: random, systematic, and judgmental sampling.

Random sampling involves collection of samples in a nonsystematic fashion from the entire site or a specific portion of a site. Systematic sampling involves collection of samples based on a grid or a pattern which has been previously established. When judgmental sampling is performed, samples are collected only from the portion(s) of the site most likely to be contaminated. Often, a combination of these strategies is the best approach depending on the type of the suspected/known contamination, the uniformity and size of the site, the level/type of information desired, etc.

7.4 QA Work Plans (QAWP)

A QAWP is required when it becomes evident that a field investigation is necessary. It should be initiated in conjunction with, or immediately following, notification of the field investigation. This plan should be clear and concise and should detail the following basic components, with regard to sampling activities:

- C Objective and purpose of the investigation.
- C Basis upon which data will be evaluated.
- C Information known about the site including location, type and size of the facility, and length of operations/abandonment.
- C Type and volume of contaminated material, contaminants of concern (including

concentration), and basis of the information/data.

- C Technical approach including media/matrix to be sampled, sampling equipment to be used, sample equipment decontamination (if necessary), sampling design and rationale, and SOPs or description of the procedure to be implemented.
- C Project management and reporting, schedule, project organization and responsibilities, manpower and cost projections, and required deliverables.
- C QA objectives and protocols including tables summarizing field sampling and QA/QC analysis and objectives.

Note that this list of QAWP components is not all-inclusive and that additional elements may be added or altered depending on the specific requirements of the field investigation. It should also be recognized that although a detailed QAWP is quite important, it may be impractical in some instances. Emergency responses and accidental spills are prime examples of such instances where time might prohibit the development of site-specific QAWPs prior to field activities. In such cases, investigators would have to rely on general guidelines and personal judgment, and the sampling or response plans might simply be a strategy based on preliminary information and finalized on site. In any event, a plan of action should be developed, no matter how concise or informal, to aid investigators in maintaining a logical and consistent order to the implementation of their task.

7.5 Legal Implications

The data derived from sampling activities are often introduced as critical evidence during litigation of a hazardous waste site cleanup. Legal issues in which sampling data are important may include cleanup cost recovery, identification of pollution sources and responsible parties, and technical validation of remedial design methodologies. Because of the potential for involvement in legal actions, strict adherence to technical and administrative SOPs is essential during both the development and implementation of sampling activities.

Technically valid sampling begins with thorough planning and continues through the sample collection and analytical procedures. Administrative requirements involve thorough, accurate

documentation of all sampling activities. Documentation requirements include maintenance of a chain of custody, as well as accurate records of field activities and analytical instructions. Failure to observe these procedures fully and consistently may result in data that are questionable, invalid and non-defensible in court, and the consequent loss of enforcement proceedings.

8.0 CALCULATIONS

Refer to the specific SOPs for any calculations which are associated with sampling techniques.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

Refer to the specific SOPs for the type and frequency of QA/QC samples to be analyzed, the acceptance criteria for the QA/QC samples, and any other QA/QC activities which are associated with sampling techniques.

10.0 DATA VALIDATION

Refer to the specific SOPs for data validation activities that are associated with sampling techniques.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA, and corporate health and safety procedures.



SAMPLING EQUIPMENT DECONTAMINATION

SOP#: 2006
DATE: 08/11/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide a description of the methods used for preventing, minimizing, or limiting cross-contamination of samples due to inappropriate or inadequate equipment decontamination and to provide general guidelines for developing decontamination procedures for sampling equipment to be used during hazardous waste operations as per 29 Code of Federal Regulations (CFR) 1910.120. This SOP does not address personnel decontamination.

These are standard (i.e. typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitation, or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Removing or neutralizing contaminants from equipment minimizes the likelihood of sample cross contamination, reduces or eliminates transfer of contaminants to clean areas, and prevents the mixing of incompatible substances.

Gross contamination can be removed by physical decontamination procedures. These abrasive and non-abrasive methods include the use of brushes, air and wet blasting, and high and low pressure water cleaning.

The first step, a soap and water wash, removes all visible particulate matter and residual oils and grease. This may be preceded by a steam or high pressure

water wash to facilitate residuals removal. The second step involves a tap water rinse and a distilled/deionized water rinse to remove the detergent. An acid rinse provides a low pH media for trace metals removal and is included in the decontamination process if metal samples are to be collected. It is followed by another distilled/deionized water rinse. If sample analysis does not include metals, the acid rinse step can be omitted. Next, a high purity solvent rinse is performed for trace organics removal if organics are a concern at the site. Typical solvents used for removal of organic contaminants include acetone, hexane, or water. Acetone is typically chosen because it is an excellent solvent, miscible in water, and not a target analyte on the Priority Pollutant List. If acetone is known to be a contaminant of concern at a given site or if Target Compound List analysis (which includes acetone) is to be performed, another solvent may be substituted. The solvent must be allowed to evaporate completely and then a final distilled/deionized water rinse is performed. This rinse removes any residual traces of the solvent.

The decontamination procedure described above may be summarized as follows:

1. Physical removal
2. Non-phosphate detergent wash
3. Tap water rinse
4. Distilled/deionized water rinse
5. 10% nitric acid rinse
6. Distilled/deionized water rinse
7. Solvent rinse (pesticide grade)
8. Air dry
9. Distilled/deionized water rinse

If a particular contaminant fraction is not present at the site, the nine (9) step decontamination procedure specified above may be modified for site specificity. For example, the nitric acid rinse may be eliminated if metals are not of concern at a site. Similarly, the solvent rinse may be eliminated if organics are not of

concern at a site. Modifications to the standard procedure should be documented in the site specific work plan or subsequent report.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

The amount of sample to be collected and the proper sample container type (i.e., glass, plastic), chemical preservation, and storage requirements are dependent on the matrix being sampled and the parameter(s) of interest.

More specifically, sample collection and analysis of decontamination waste may be required before beginning proper disposal of decontamination liquids and solids generated at a site. This should be determined prior to initiation of site activities.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

- C The use of distilled/deionized water commonly available from commercial vendors may be acceptable for decontamination of sampling equipment provided that it has been verified by laboratory analysis to be analyte free (specifically for the contaminants of concern).
- C The use of an untreated potable water supply is not an acceptable substitute for tap water. Tap water may be used from any municipal or industrial water treatment system.
- C If acids or solvents are utilized in decontamination they raise health and safety, and waste disposal concerns.
- C Damage can be incurred by acid and solvent washing of complex and sophisticated sampling equipment.

5.0 EQUIPMENT/APPARATUS

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations include the ease of decontaminating or disposing of the equipment. Most equipment and supplies can be easily procured. For example, soft-

bristle scrub brushes or long-handled bottle brushes can be used to remove contaminants. Large galvanized wash tubs, stock tanks, or buckets can hold wash and rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags can help segregate contaminated equipment. Contaminated liquid can be stored temporarily in metal or plastic cans or drums.

The following standard materials and equipment are recommended for decontamination activities:

5.1 Decontamination Solutions

- C Non-phosphate detergent
- C Selected solvents (acetone, hexane, nitric acid, etc.)
- C Tap water
- C Distilled or deionized water

5.2 Decontamination Tools/Supplies

- C Long and short handled brushes
- C Bottle brushes
- C Drop cloth/plastic sheeting
- C Paper towels
- C Plastic or galvanized tubs or buckets
- C Pressurized sprayers (H₂O)
- C Solvent sprayers
- C Aluminum foil

5.3 Health and Safety Equipment

Appropriate personal protective equipment (i.e., safety glasses or splash shield, appropriate gloves, aprons or coveralls, respirator, emergency eye wash)

5.4 Waste Disposal

- C Trash bags
- C Trash containers
- C 55-gallon drums
- C Metal/plastic buckets/containers for storage and disposal of decontamination solutions

6.0 REAGENTS

There are no reagents used in this procedure aside from the actual decontamination solutions. Table 1 (Appendix A) lists solvent rinses which may be required for elimination of particular chemicals. In

general, the following solvents are typically utilized for decontamination purposes:

- C 10% nitric acid is typically used for inorganic compounds such as metals. An acid rinse may not be required if inorganics are not a contaminant of concern.
- C Acetone (pesticide grade)⁽¹⁾
- C Hexane (pesticide grade)⁽¹⁾
- C Methanol⁽¹⁾

⁽¹⁾ - Only if sample is to be analyzed for organics.

7.0 PROCEDURES

As part of the health and safety plan, a decontamination plan should be developed and reviewed. The decontamination line should be set up before any personnel or equipment enter the areas of potential exposure. The equipment decontamination plan should include:

- C The number, location, and layout of decontamination stations.
- C Decontamination equipment needed.
- C Appropriate decontamination methods.
- C Methods for disposal of contaminated clothing, equipment, and solutions.
- C Procedures can be established to minimize the potential for contamination. This may include: (1) work practices that minimize contact with potential contaminants; (2) using remote sampling techniques; (3) covering monitoring and sampling equipment with plastic, aluminum foil, or other protective material; (4) watering down dusty areas; (5) avoiding laying down equipment in areas of obvious contamination; and (6) use of disposable sampling equipment.

7.1 Decontamination Methods

All samples and equipment leaving the contaminated area of a site must be decontaminated to remove any contamination that may have adhered to equipment. Various decontamination methods will remove contaminants by: (1) flushing or other physical action, or (2) chemical complexing to inactivate

contaminants by neutralization, chemical reaction, disinfection, or sterilization.

Physical decontamination techniques can be grouped into two categories: abrasive methods and non-abrasive methods, as follows:

7.1.1 Abrasive Cleaning Methods

Abrasive cleaning methods work by rubbing and wearing away the top layer of the surface containing the contaminant. The mechanical abrasive cleaning methods are most commonly used at hazardous waste sites. The following abrasive methods are available:

Mechanical

Mechanical methods of decontamination include using metal or nylon brushes. The amount and type of contaminants removed will vary with the hardness of bristles, length of time brushed, degree of brush contact, degree of contamination, nature of the surface being cleaned, and degree of contaminant adherence to the surface.

Air Blasting

Air blasting equipment uses compressed air to force abrasive material through a nozzle at high velocities. The distance between nozzle and surface cleaned, air pressure, time of application, and angle at which the abrasive strikes the surface will dictate cleaning efficiency. Disadvantages of this method are the inability to control the amount of material removed and the large amount of waste generated.

Wet Blasting

Wet blast cleaning involves use of a suspended fine abrasive. The abrasive/water mixture is delivered by compressed air to the contaminated area. By using a very fine abrasive, the amount of materials removed can be carefully controlled.

7.1.2 Non-Abrasive Cleaning Methods

Non-abrasive cleaning methods work by forcing the contaminant off a surface with pressure. In general, the equipment surface is not removed using non-abrasive methods.

Low-Pressure Water

This method consists of a container which is filled with water. The user pumps air out of the container to create a vacuum. A slender nozzle and hose allow the user to spray in hard-to-reach places.

High-Pressure Water

This method consists of a high-pressure pump, an operator controlled directional nozzle, and a high-pressure hose. Operating pressure usually ranges from 340 to 680 atmospheres (atm) and flow rates usually range from 20 to 140 liters per minute.

Ultra-High-Pressure Water

This system produces a water jet that is pressured from 1,000 to 4,000 atmospheres. This ultra-high-pressure spray can remove tightly-adhered surface films. The water velocity ranges from 500 meters/second (m/s) (1,000 atm) to 900 m/s (4,000 atm). Additives can be used to enhance the cleaning action.

Rinsing

Contaminants are removed by rinsing through dilution, physical attraction, and solubilization.

Damp Cloth Removal

In some instances, due to sensitive, non-waterproof equipment or due to the unlikelihood of equipment being contaminated, it is not necessary to conduct an extensive decontamination procedure. For example, air sampling pumps hooked on a fence, placed on a drum, or wrapped in plastic bags are not likely to become heavily contaminated. A damp cloth should be used to wipe off contaminants which may have adhered to equipment through airborne contaminants or from surfaces upon which the equipment was set.

Disinfection/Sterilization

Disinfectants are a practical means of inactivating infectious agents. Unfortunately, standard sterilization methods are impractical for large equipment. This method of decontamination is typically performed off-site.

7.2 Field Sampling Equipment Decontamination Procedures

The decontamination line is setup so that the first station is used to clean the most contaminated item. It progresses to the last station where the least contaminated item is cleaned. The spread of contaminants is further reduced by separating each decontamination station by a minimum of three (3) feet. Ideally, the contamination should decrease as the equipment progresses from one station to another farther along in the line.

A site is typically divided up into the following boundaries: Hot Zone or Exclusion Zone (EZ), the Contamination Reduction Zone (CRZ), and the Support or Safe Zone (SZ). The decontamination line should be setup in the Contamination Reduction Corridor (CRC) which is in the CRZ. Figure 1 (Appendix B) shows a typical contaminant reduction zone layout. The CRC controls access into and out of the exclusion zone and confines decontamination activities to a limited area. The CRC boundaries should be conspicuously marked. The far end is the hotline, the boundary between the exclusion zone and the contamination reduction zone. The size of the decontamination corridor depends on the number of stations in the decontamination process, overall dimensions of the work zones, and amount of space available at the site. Whenever possible, it should be a straight line.

Anyone in the CRC should be wearing the level of protection designated for the decontamination crew. Another corridor may be required for the entry and exit of heavy equipment. Sampling and monitoring equipment and sampling supplies are all maintained outside of the CRC. Personnel don their equipment away from the CRC and enter the exclusion zone through a separate access control point at the hotline. One person (or more) dedicated to decontaminating equipment is recommended.

7.2.1 Decontamination Setup

Starting with the most contaminated station, the decontamination setup should be as follows:

Station 1: Segregate Equipment Drop

Place plastic sheeting on the ground (Figure 2, Appendix B). Size will depend on amount of

equipment to be decontaminated. Provide containers lined with plastic if equipment is to be segregated. Segregation may be required if sensitive equipment or mildly contaminated equipment is used at the same time as equipment which is likely to be heavily contaminated.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

As indicated in 7.1.2, a high-pressure wash may be required for compounds which are difficult to remove by washing with brushes. The elevated temperature of the water from the high-pressure washers is excellent at removing greasy/oily compounds. High pressure washers require water and electricity.

A decontamination pad may be required for the high-pressure wash area. An example of a wash pad may consist of an approximately 1 1/2 foot-deep basin lined with plastic sheeting and sloped to a sump at one corner. A layer of sand can be placed over the plastic and the basin is filled with gravel or shell. The sump is also lined with visqueen and a barrel is placed in the hole to prevent collapse. A sump pump is used to remove the water from the sump for transfer into a drum.

Typically heavy machinery is decontaminated at the end of the day unless site sampling requires that the machinery be decontaminated frequently. A separate decontamination pad may be required for heavy equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Prior to setting up Station 3, place plastic sheeting on the ground to cover areas under Station 3 through Station 10.

Fill a wash basin, a large bucket, or child's swimming pool with non-phosphate detergent and tap water. Several bottle and bristle brushes to physically remove contamination should be dedicated to this station. Approximately 10 - 50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 4: Water Basin

Fill a wash basin, a large bucket, or child's swimming

pool with tap water. Several bottle and bristle brushes should be dedicated to this station. Approximately 10-50 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 5: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to contain the water during the rinsing process. Approximately 10-20 gallons of water may be required initially depending upon the amount of equipment to decontaminate and the amount of gross contamination.

Station 6: Nitric Acid Sprayers

Fill a spray bottle with 10% nitric acid. An acid rinse may not be required if inorganics are not a contaminant of concern. The amount of acid will depend on the amount of equipment to be decontaminated. Provide a 5-gallon bucket or basin to collect acid during the rinsing process.

Station 7: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 8: Organic Solvent Sprayers

Fill a spray bottle with an organic solvent. After each solvent rinse, the equipment should be rinsed with distilled/deionized water and air dried. Amount of solvent will depend on the amount of equipment to decontaminate. Provide a 5-gallon bucket or basin to collect the solvent during the rinsing process.

Solvent rinses may not be required unless organics are a contaminant of concern, and may be eliminated from the station sequence.

Station 9: Low-Pressure Sprayers

Fill a low-pressure sprayer with distilled/deionized water. Provide a 5-gallon bucket or basin to collect water during the rinsate process.

Station 10: Clean Equipment Drop

Lay a clean piece of plastic sheeting over the bottom

plastic layer. This will allow easy removal of the plastic in the event that it becomes dirty. Provide aluminum foil, plastic, or other protective material to wrap clean equipment.

7.2.2 Decontamination Procedures

Station 1: Segregate Equipment Drop

Deposit equipment used on-site (i.e., tools, sampling devices and containers, monitoring instruments radios, clipboards, etc.) on the plastic drop cloth/sheet or in different containers with plastic liners. Each will be contaminated to a different degree. Segregation at the drop reduces the probability of cross contamination. Loose leaf sampling data sheets or maps can be placed in plastic zip lock bags if contamination is evident.

Station 2: Physical Removal With A High-Pressure Washer (Optional)

Use high pressure wash on grossly contaminated equipment. Do not use high- pressure wash on sensitive or non-waterproof equipment.

Station 3: Physical Removal With Brushes And A Wash Basin

Scrub equipment with soap and water using bottle and bristle brushes. Only sensitive equipment (i.e., radios, air monitoring and sampling equipment) which is waterproof should be washed. Equipment which is not waterproof should have plastic bags removed and wiped down with a damp cloth. Acids and organic rinses may also ruin sensitive equipment. Consult the manufacturers for recommended decontamination solutions.

Station 4: Equipment Rinse

Wash soap off of equipment with water by immersing the equipment in the water while brushing. Repeat as many times as necessary.

Station 5: Low-Pressure Rinse

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 6: Nitric Acid Sprayers (required only if metals are a contaminant of concern)

Using a spray bottle rinse sampling equipment with nitric acid. Begin spraying (inside and outside) at one end of the equipment allowing the acid to drip to the other end into a 5-gallon bucket. A rinsate blank may be required at this station. Refer to Section 9.

Station 7: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure sprayer.

Station 8: Organic Solvent Sprayers

Rinse sampling equipment with a solvent. Begin spraying (inside and outside) at one end of the equipment allowing the solvent to drip to the other end into a 5-gallon bucket. Allow the solvent to evaporate from the equipment before going to the next station. A QC rinsate sample may be required at this station.

Station 9: Low-Pressure Sprayers

Rinse sampling equipment with distilled/deionized water with a low-pressure washer.

Station 10: Clean Equipment Drop

Lay clean equipment on plastic sheeting. Once air dried, wrap sampling equipment with aluminum foil, plastic, or other protective material.

7.2.3 Post Decontamination Procedures

1. Collect high-pressure pad and heavy equipment decontamination area liquid and waste and store in appropriate drum or container. A sump pump can aid in the collection process. Refer to the Department of Transportation (DOT) requirements for appropriate containers based on the contaminant of concern.
2. Collect high-pressure pad and heavy equipment decontamination area solid waste and store in appropriate drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
3. Empty soap and water liquid wastes from basins and buckets and store in appropriate

drum or container. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.

4. Empty acid rinse waste and place in appropriate container or neutralize with a base and place in appropriate drum. pH paper or an equivalent pH test is required for neutralization. Consult DOT requirements for appropriate drum for acid rinse waste.
5. Empty solvent rinse sprayer and solvent waste into an appropriate container. Consult DOT requirements for appropriate drum for solvent rinse waste.
6. Using low-pressure sprayers, rinse basins, and brushes. Place liquid generated from this process into the wash water rinse container.
7. Empty low-pressure sprayer water onto the ground.
8. Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved DOT drum. Refer to the DOT requirements for appropriate containers based on the contaminant of concern.
9. Write appropriate labels for waste and make arrangements for disposal. Consult DOT regulations for the appropriate label for each drum generated from the decontamination process.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

A rinsate blank is one specific type of quality control sample associated with the field decontamination process. This sample will provide information on the effectiveness of the decontamination process employed in the field.

Rinsate blanks are samples obtained by running analyte free water over decontaminated sampling

equipment to test for residual contamination. The blank water is collected in sample containers for handling, shipment, and analysis. These samples are treated identical to samples collected that day. A rinsate blank is used to assess cross contamination brought about by improper decontamination procedures. Where dedicated sampling equipment is not utilized, collect one rinsate blank per day per type of sampling device samples to meet QA2 and QA3 objectives.

If sampling equipment requires the use of plastic tubing it should be disposed of as contaminated and replaced with clean tubing before additional sampling occurs.

10.0 DATA VALIDATION

Results of quality control samples will be evaluated for contamination. This information will be utilized to qualify the environmental sample results in accordance with the project's data quality objectives.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow OSHA, U.S. EPA, corporate, and other applicable health and safety procedures.

Decontamination can pose hazards under certain circumstances. Hazardous substances may be incompatible with decontamination materials. For example, the decontamination solution may react with contaminants to produce heat, explosion, or toxic products. Also, vapors from decontamination solutions may pose a direct health hazard to workers by inhalation, contact, fire, or explosion.

The decontamination solutions must be determined to be acceptable before use. Decontamination materials may degrade protective clothing or equipment; some solvents can permeate protective clothing. If decontamination materials do pose a health hazard, measures should be taken to protect personnel or substitutions should be made to eliminate the hazard. The choice of respiratory protection based on contaminants of concern from the site may not be appropriate for solvents used in the decontamination process.

Safety considerations should be addressed when using abrasive and non-abrasive decontamination

equipment. Maximum air pressure produced by abrasive equipment could cause physical injury. Displaced material requires control mechanisms.

Material generated from decontamination activities requires proper handling, storage, and disposal. Personal Protective Equipment may be required for these activities.

Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard (i.e., acetone, alcohol, and trisodiumphosphate).

In some jurisdictions, phosphate containing detergents (i.e., TSP) are banned.

12.0 REFERENCES

Field Sampling Procedures Manual, New Jersey Department of Environmental Protection, February, 1988.

A Compendium of Superfund Field Operations Methods, EPA 540/p-87/001.

Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, USEPA Region IV, April 1, 1986.

Guidelines for the Selection of Chemical Protective Clothing, Volume 1, Third Edition, American Conference of Governmental Industrial Hygienists, Inc., February, 1987.

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, NIOSH/OSHA/USCG/EPA, October, 1985.

APPENDIX A

Table

Table 1. Soluble Contaminants and Recommended Solvent Rinse

TABLE 1 Soluble Contaminants and Recommended Solvent Rinse		
SOLVENT ⁽¹⁾	EXAMPLES OF SOLVENTS	SOLUBLE CONTAMINANTS
Water	Deionized water Tap water	Low-chain hydrocarbons Inorganic compounds Salts Some organic acids and other polar compounds
Dilute Acids	Nitric acid Acetic acid Boric acid	Basic (caustic) compounds (e.g., amines and hydrazines)
Dilute Bases	Sodium bicarbonate (e.g., soap detergent)	Acidic compounds Phenol Thiols Some nitro and sulfonic compounds
Organic Solvents ⁽²⁾	Alcohols Ethers Ketones Aromatics Straight chain alkalines (e.g., hexane) Common petroleum products (e.g., fuel, oil, kerosene)	Nonpolar compounds (e.g., some organic compounds)
Organic Solvent ⁽²⁾	Hexane	PCBs

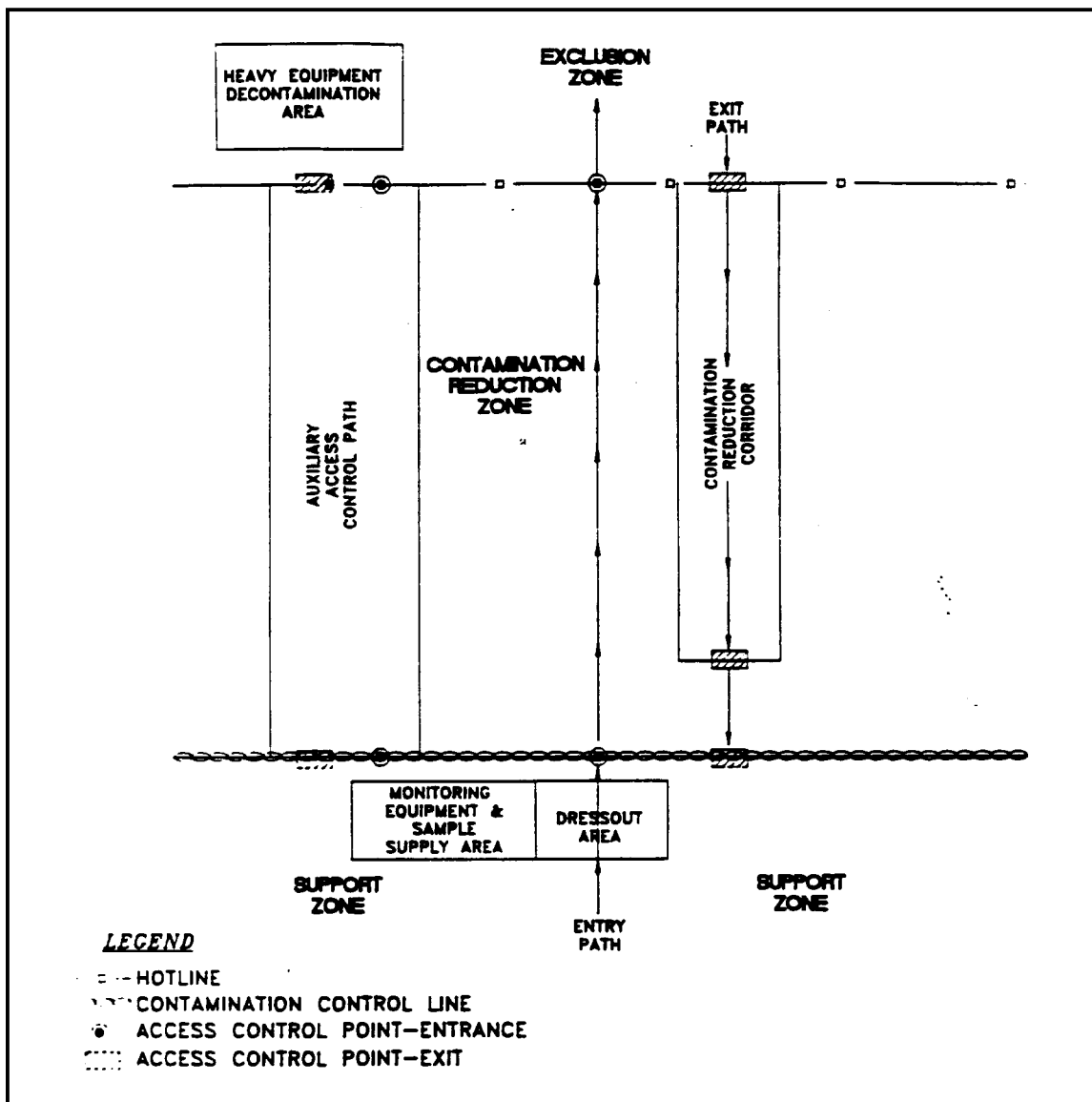
⁽¹⁾ - Material safety data sheets are required for all decontamination solvents or solutions as required by the Hazard Communication Standard

⁽²⁾ - WARNING: Some organic solvents can permeate and/or degrade the protective clothing

APPENDIX B

Figures

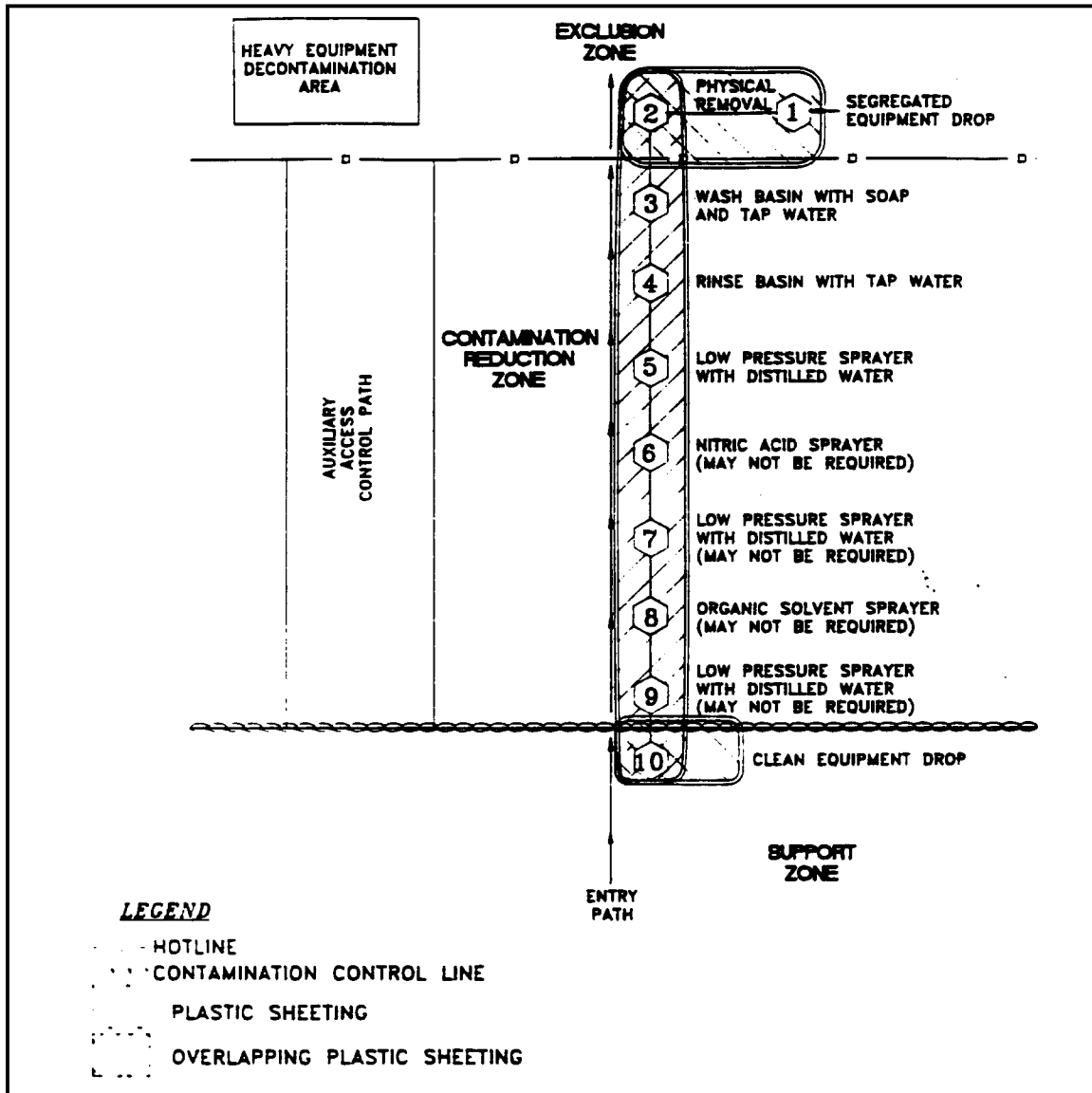
Figure 1. Contamination Reduction Zone Layout



APPENDIX B (Cont'd.)

Figures

Figure 2. Decontamination Layout





SURFACE WATER SAMPLING

SOP#: 2013
DATE: 11/17/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative liquid samples, both aqueous and non-aqueous from streams, rivers, lakes, ponds, lagoons, and surface impoundments. It includes samples collected from depth, as well as samples collected from the surface.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent upon site conditions, equipment limitations or limitations imposed by the procedure or other procedure limitations. In all instances, the ultimate procedures employed should be documented and associated with the final report.

Mention of trade names or commercial products does not constitute U.S. Environmental Protection Agency (EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sampling situations vary widely, therefore, no universal sampling procedure can be recommended. However, sampling of both aqueous and non-aqueous liquids from the above mentioned sources is generally accomplished through the use of one of the following samplers or techniques:

- C Kemmerer bottle
- C Bacon bomb sampler
- C Dip sampler
- C Direct method

These sampling techniques will allow for the collection of representative samples from the majority of surface waters and impoundments encountered.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

Once samples have been collected, the following procedure should be followed:

1. Transfer the sample(s) into suitable, labeled sample containers.
2. Preserve the sample if appropriate, or use pre-preserved sample bottles. Do not overfill bottles if they are pre-preserved.
3. Cap the container, place in a ziploc plastic bag and cool to 4°C.
4. Record all pertinent data in the site logbook and on field data sheets.
5. Complete the Chain of Custody record.
6. Attach custody seals to cooler prior to shipment.
7. Decontaminate all sampling equipment prior to the collection of additional samples with that sampling device.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

There are two primary interferences or potential problems with surface water sampling. These include cross contamination of samples and improper sample collection.

1. Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment. If this is not possible or practical, then decontamination of sampling equipment is necessary. Refer to the Sampling Equipment Decontamination SOP.
2. Improper sample collection can involve using contaminated equipment, disturbance of the stream or impoundment substrate, and sampling in an obviously disturbed area.

Following proper decontamination procedures and minimizing disturbance of the sample site will eliminate these problems.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of surface water samples may include (depending on technique chosen):

- C Kemmerer bottles
- C Bacon bomb sampler
- C Dip sampler
- C Line and messengers
- C Sample bottles/preservatives
- C Ziploc bags
- C Ice
- C Coolers
- C Chain of Custody records, custody seals
- C Field data sheets
- C Decontamination equipment
- C Maps/plot plan
- C Safety equipment
- C Compass
- C Tape measure
- C Survey stakes, flags, or buoys and anchors
- C Camera and film
- C Logbook/waterproof pen
- C Sample bottle labels

6.0 REAGENTS

Reagents will be utilized for preservation of samples and for decontamination of sampling equipment. The preservatives required are specified by the analysis to be performed.

7.0 PROCEDURES

7.1 Preparation

1. Determine the extent of the sampling effort, the sampling methods to be employed, and the types and amounts of equipment and supplies needed.
2. Obtain the necessary sampling and monitoring equipment.
3. Decontaminate or pre-clean equipment, and ensure that it is in working order.
4. Prepare scheduling and coordinate with staff, clients, and regulatory agency, if appropriate.
5. Perform a general site survey prior to site entry, in accordance with the site specific Health and Safety Plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. If required the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions. If collecting sediment samples, this procedure may disturb the bottom.

7.2 Representative Sampling Considerations

In order to collect a representative sample, the hydrology and morphometrics of a stream or impoundment should be determined prior to sampling. This will aid in determining the presence of phases or layers in lagoons, or impoundments, flow patterns in streams, and appropriate sample locations and depths.

Water quality data should be collected in impoundments, and to determine if stratification is present. Measurements of dissolved oxygen, pH, and temperature can indicate if strata exist which would effect analytical results. Measurements should be collected at one-meter intervals from the substrate to the surface using the appropriate instrument (i.e., a Hydrolab or equivalent).

Water quality measurements such as dissolved oxygen, pH, temperature, conductivity, and oxidation-reduction potential can assist in the interpretation of analytical data and the selection of sampling sites and depths when surface water samples are collected.

Generally, the deciding factors in the selection of a sampling device for sampling liquids in streams, rivers, lakes, ponds, lagoons, and surface impoundments are:

1. Will the sample be collected from shore or from a boat?
2. What is the desired depth at which you wish to collect the sample?
3. What is the overall depth and flow direction of river or stream?
4. What type of sample will be collected (i.e., water or lagoon liquids)?

7.2.1 Sampler Composition

The appropriate sampling device must be of a proper composition. Selection of samplers constructed of glass, stainless steel, PVC or PFTE (Teflon) should be based upon the analyses to be performed.

7.3 Sample Collection

7.3.1 Kemmerer Bottle

A Kemmerer bottle (Figure 1, Appendix A) may be used in most situations where site access is from a boat or structure such as a bridge or pier, and where samples at depth are required. Sampling procedures are as follows:

1. Use a properly decontaminated Kemmerer bottle. Set the sampling device so that the sampling end pieces (upper and lower stoppers) are pulled away from the sampling tube (body), allowing the substance to be sampled to pass through this tube.
2. Lower the pre-set sampling device to the predetermined depth. Avoid bottom disturbance.

3. When the Kemmerer bottle is at the required depth, send down the messenger, closing the sampling device.
4. Retrieve the sampler and discharge from the bottom drain the first 10-20 mL to clear any potential contamination of the valve. Transfer the sample to the appropriate sample container.

7.3.2 Bacon Bomb Sampler

A bacon bomb sampler (Figure 2, Appendix A) may be used in situations similar to those outlined for the Kemmerer bottle. Sampling procedures are as follows:

1. Lower the bacon bomb sampler carefully to the desired depth, allowing the line for the trigger to remain slack at all times. When the desired depth is reached, pull the trigger line until taut. This will allow the sampler to fill.
2. Release the trigger line and retrieve the sampler.
3. Transfer the sample to the appropriate sample container by pulling up on the trigger.

7.3.3 Dip Sampler

A dip sampler (Figure 3, Appendix A) is useful in situations where a sample is to be recovered from an outfall pipe or along a lagoon bank where direct access is limited. The long handle on such a device allows access from a discrete location. Sampling procedures are as follows:

1. Assemble the device in accordance with the manufacturer's instructions.
2. Extend the device to the sample location and collect the sample by dipping the sampler into the substance.
3. Retrieve the sampler and transfer the sample to the appropriate sample container.

7.3.4 Direct Method

For streams, rivers, lakes, and other surface waters, the direct method may be utilized to collect water samples from the surface directly into the sample bottle. This method is not to be used for sampling lagoons or other impoundments where contact with contaminants is a concern.

Using adequate protective clothing, access the sampling station by appropriate means. For shallow stream stations, collect the sample under the water surface while pointing the sample container upstream; the container must be upstream of the collector. Avoid disturbing the substrate. For lakes and other impoundments, collect the sample under the water surface avoiding surface debris and the boat wake.

When using the direct method, do not use pre-preserved sample bottles as the collection method may dilute the concentration of preservative necessary for proper sample preservation.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following general QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA, OSHA and corporate health and safety procedures.

More specifically, when sampling lagoons or surface impoundments containing known or suspected hazardous substances, adequate precautions must be taken to ensure the safety of sampling personnel. The sampling team member collecting the sample should not get too close to the edge of the impoundment, where bank failure may cause him/her to lose his/her balance. The person performing the sampling should be on a lifeline and be wearing adequate protective equipment. When conducting sampling from a boat in an impoundment or flowing waters, appropriate boating safety procedures should be followed.

12.0 REFERENCES

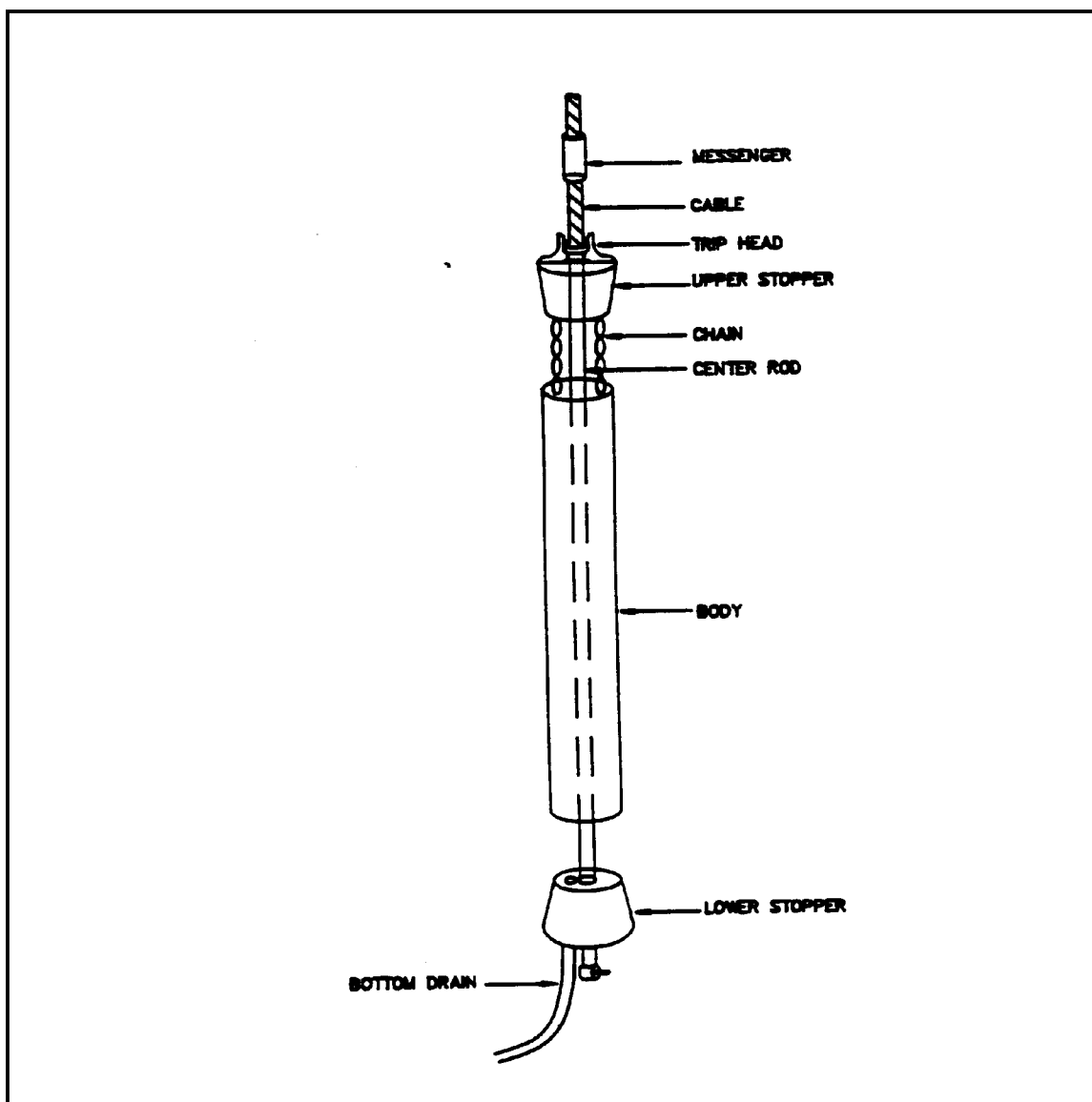
U.S. Geological Survey. 1977. National Handbook or Recommended Methods for Water Data Acquisition. Office of Water Data Coordination Reston, Virginia. (Chapter Updates available).

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. EPA/600/4-84-076.

APPENDIX A

Figures

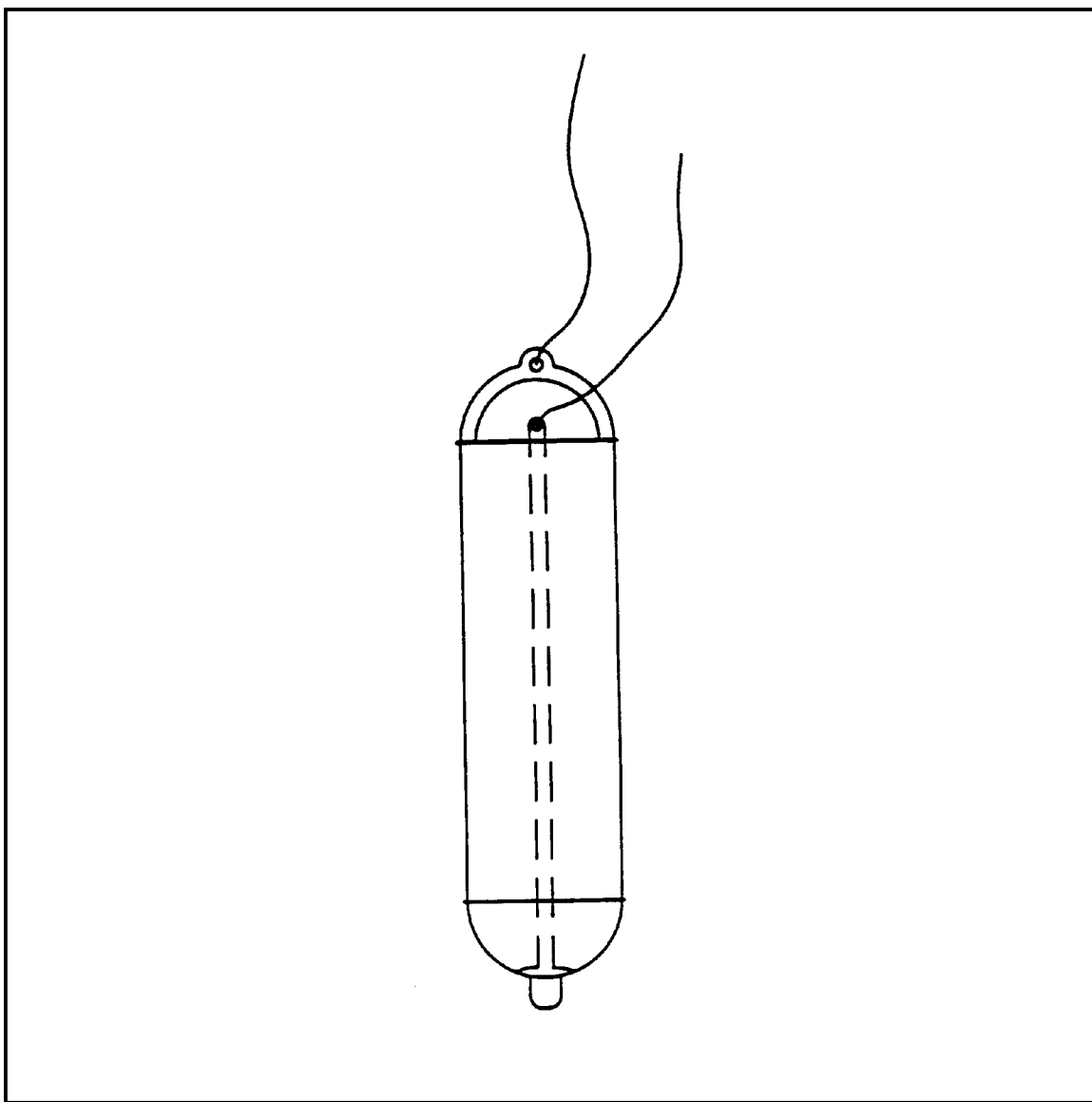
FIGURE 1. Kemmerer Bottle



APPENDIX A (Cont'd)

Figures

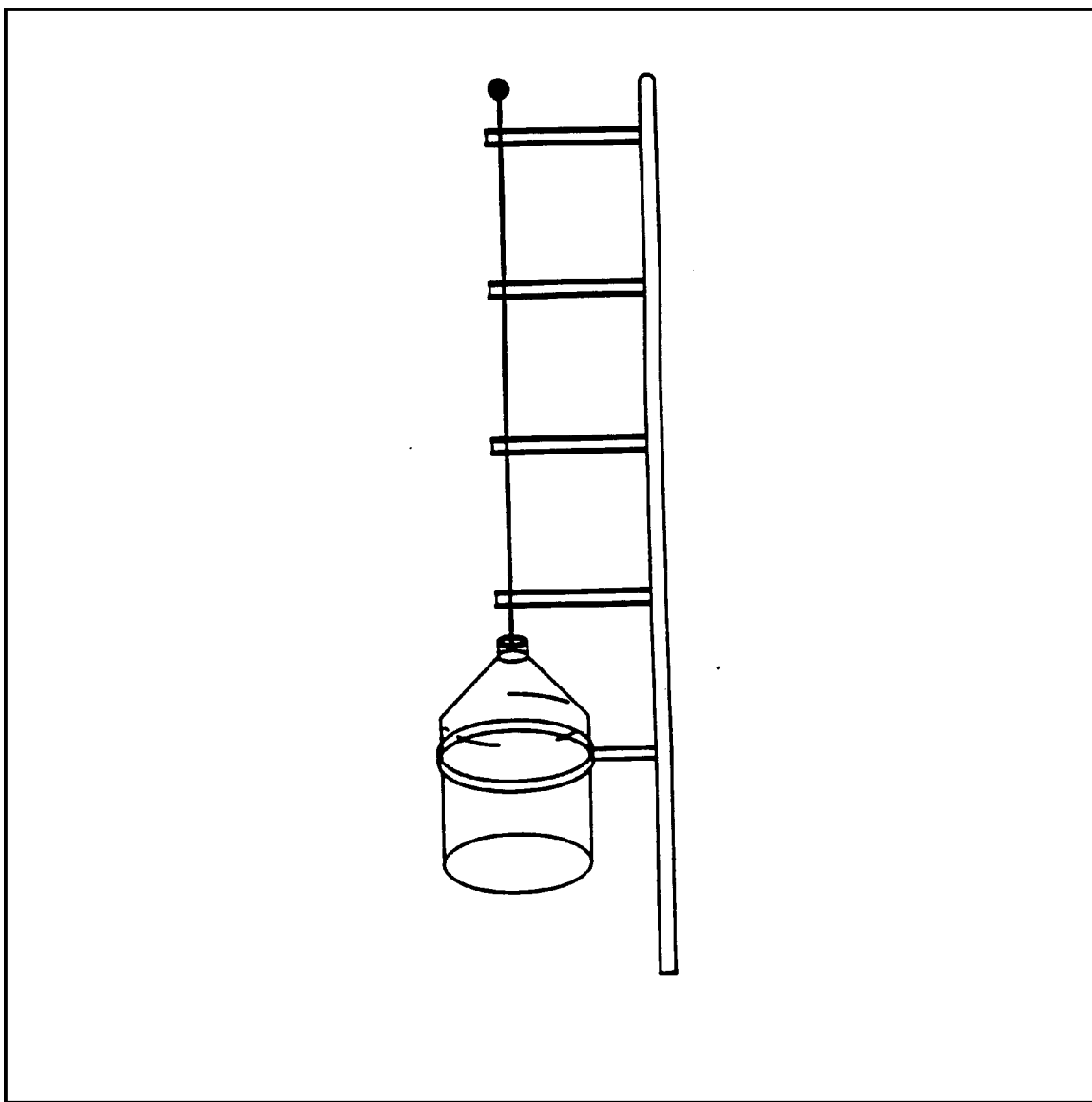
FIGURE 2. Bacon Bomb Sampler



APPENDIX A (Cont'd)

Figures

FIGURE 3. Dip Sampler





SEDIMENT SAMPLING

SOP#: 2016
DATE: 11/17/94
REV. #: 0.0

1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) is applicable to the collection of representative sediment samples. Analysis of sediment may be biological, chemical, or physical in nature and may be used to determine the following:

- C toxicity;
- C biological availability and effects of contaminants;
- C benthic biota;
- C extent and magnitude of contamination;
- C contaminant migration pathways and source;
- C fate of contaminants;
- C grain size distribution.

The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. However, if modifications occur, they should be documented in a site or personal logbook and discussed in reports summarizing field activities and analytical results.

For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer. The aqueous layer may be either static, as in lakes, ponds, and impoundments; or flowing, as in rivers and streams.

Mention of trade names or commercial products does not constitute U.S. EPA endorsement or recommendation for use.

2.0 METHOD SUMMARY

Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the aqueous layer, the portion of the sediment profile

required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed), contaminants present, and sediment type.

Sediment is collected from beneath an aqueous layer either directly, using a hand held device such as a shovel, trowel, or auger; or indirectly, using a remotely activated device such as an Ekman or Ponar dredge. Following collection, sediment is transferred from the sampling device to a sample container of appropriate size and construction for the analyses requested. If composite sampling techniques are employed, multiple grabs are placed into a container constructed of inert material, homogenized, and transferred to sample containers appropriate for the analyses requested. The homogenization procedure should not be used if sample analysis includes volatile organics; in this case, sediment, or multiple grabs of sediment, should be transferred directly from the sample collection device or homogenization container to the sample container.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING AND STORAGE

1. Chemical preservation of solids is generally not recommended. Cooling to 4°C is usually the best approach, supplemented by the appropriate holding time for the analyses requested.
2. Wide mouth glass containers with Teflon lined caps are utilized for sediment samples. The sample volume is a function of the analytical requirements and will be specified in the Work Plan.
3. If analysis of sediment from a discrete depth or location is desired, sediment is transferred directly from the sampling device to a labeled sample container(s) of appropriate size and construction for the analyses

requested. Transfer is accomplished with a stainless steel or plastic lab spoon or equivalent.

4. If composite sampling techniques or multiple grabs are employed, equal portions of sediment from each location are deposited into a stainless steel, plastic, or other appropriate composition (e.g., Teflon) containers. The sediment is homogenized thoroughly to obtain a composite representative of the area sampled. The composite sediment sample is transferred to a labeled container(s) of appropriate size and construction for the analyses requested. Transfer of sediment is accomplished with a stainless steel or plastic lab spoon or equivalent. Samples for volatile organic analysis must be transferred directly from the sample collection device or pooled from multiple areas in the homogenization container prior to mixing. This is done to minimize loss of contaminant due to volatilization during homogenization.
5. All sampling devices should be decontaminated, then wrapped in aluminum foil. The sampling device should remain in this wrapping until it is needed. Each sampling device should be used for only one sample. Disposable sampling devices for sediment are generally impractical due to cost and the large number of sediment samples which may be required. Sampling devices should be cleaned in the field using the decontamination procedure described in the Sampling Equipment Decontamination SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

Substrate particle size and organic matter content are a direct consequence of the flow characteristics of a waterbody. Contaminants are more likely to be concentrated in sediments typified by fine particle size and a high organic matter content. This type of sediment is most likely to be collected from depositional zones. In contrast, coarse sediments with low organic matter content do not typically concentrate pollutants and are generally found in erosional zones. The selection of a sampling location

can, therefore, greatly influence the analytical results and should be justified and specified in the Work Plan.

5.0 EQUIPMENT/APPARATUS

Equipment needed for collection of sediment samples may include:

- C Maps/plot plan
- C Safety equipment
- C Compass
- C Tape measure
- C Survey stakes, flags, or buoys and anchors
- C Camera and film
- C Stainless steel, plastic, or other appropriate composition bucket
- C 4-oz., 8-oz., and one-quart wide mouth jars w/Teflon lined lids
- C Ziploc plastic bags
- C Logbook
- C Sample jar labels
- C Chain of Custody records, field data sheets
- C Cooler(s)
- C Ice
- C Decontamination supplies/equipment
- C Spade or shovel
- C Spatula
- C Scoop
- C Trowel
- C Bucket auger
- C Tube auger
- C Extension rods
- C "T" handle
- C Sediment coring device (tube, drive head, eggshell check valve, nosecone, acetate tube, extension rods, "T" handle)
- C Ponar dredge
- C Ekman dredge
- C Nylon rope or steel cable
- C Messenger device

6.0 REAGENTS

Reagents are not used for preservation of sediment samples. Decontamination solutions are specified in the Sampling Equipment Decontamination SOP.

7.0 PROCEDURES

7.1 Preparation

1. Determine the objective(s) and extent of the sampling effort. The sampling methods to be employed, and the types and amounts of equipment and supplies required will be a function of site characteristics and objectives of the study.
2. Obtain the necessary sampling and monitoring equipment.
3. Prepare schedules, and coordinate with staff, client, and regulatory agencies, if appropriate.
4. Decontaminate or preclean equipment, and ensure that it is in working order.
5. Perform a general site survey prior to site entry in accordance with the site specific Health and Safety Plan.
6. Use stakes, flagging, or buoys to identify and mark all sampling locations. Specific site factors including flow regime, basin morphometry, sediment characteristics, depth of overlying aqueous layer, contaminant source, and extent and nature of contamination should be considered when selecting sample locations. If required, the proposed locations may be adjusted based on site access, property boundaries, and surface obstructions.

7.2 Sample Collection

Selection of a sampling device is most often contingent upon: (1) the depth of water at the sampling location, and (2) the physical characteristics of the sediment to be sampled. The following procedures may be utilized:

7.2.1 Sampling Surface Sediment with a Trowel or Scoop from Beneath a Shallow Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth and

a shallow aqueous layer is considered to range from 0 to 12 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with tools such as spades, shovels, trowels, and scoops. Although this method can be used to collect both unconsolidated/consolidated sediment, it is limited somewhat by the depth and movement of the aqueous layer. Deep and rapidly flowing water render this method less accurate than others discussed below. However, representative samples can be collected with this procedure in shallow sluggish water provided care is demonstrated by the sample team member. A stainless steel or plastic sampling implement will suffice in most applications. Care should be exercised to avoid the use of devices plated with chrome or other materials; plating is particularly common with garden trowels.

The following procedure will be used to collect sediment with a scoop, shovel, or trowel:

1. Using a decontaminated sampling implement, remove the desired thickness and volume of sediment from the sampling area.
2. Transfer the sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.
3. Surface water should be decanted from the sample or homogenization container prior to sealing or transfer; care should be taken to retain the fine sediment fraction during this procedure.

7.2.2 Sampling Surface Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches in depth. Collection of surface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of bucket auger or tube auger, a series of extensions, and a "T" handle (Figure 1, Appendix A). The use of additional extensions in conjunction with a bucket auger can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more. However, sample handling and manipulation increases

in difficulty with increasing depth of water. The bucket auger or tube auger is driven into the sediment and used to extract a core. The various depths represented by the core are homogenized or a subsample of the core is taken from the appropriate depth.

The following procedure will be used to collect sediment samples with a bucket auger or tube auger:

1. An acetate core may be inserted into the bucket auger or tube auger prior to sampling if characteristics of the sediments or waterbody warrant. By using this technique, an intact core can be extracted.
2. Attach the auger head to the required length of extensions, then attach the "T" handle to the upper extension.
3. Clear the area to be sampled of any surface debris.
4. Insert the bucket auger or tube auger into the sediment at a 0° to 20° angle from vertical. This orientation minimizes spillage of the sample from the sampler upon extraction from the sediment and water.
5. Rotate the auger to cut a core of sediment.
6. Slowly withdraw the auger; if using a tube auger, make sure that the slot is facing upward.
7. Transfer the sample or a specified aliquot of sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

7.2.3 Sampling Deep Sediment with a Bucket Auger or Tube Auger from Beneath a Shallow Aqueous Layer

For the purpose of this method, deep sediment is considered to range from six to greater than 18 inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches. Collection of deep sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a bucket auger, a tube auger, a series of extensions and a

"T" handle. The use of additional extensions can increase the depth of water from which sediment can be collected from 24 inches to five feet or more. However, water clarity must be high enough to permit the sampler to directly observe the sampling operation. In addition, sample handling and manipulation increases in difficulty with increasing depth of water. The bucket auger is used to bore a hole to the upper range of the desired sampling depth and then withdrawn. The tube auger is then lowered down the borehole, and driven into the sediment to the lower range of the desired sampling depth. The tube is then withdrawn and the sample recovered from the tube. This method can be used to collect firmly consolidated sediments, but is somewhat limited by the depth of the aqueous layer, and the integrity of the initial borehole.

The following procedure will be used to collect deep sediment samples with a bucket auger and a tube auger:

1. Attach the bucket auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.
2. Clear the area to be sampled of any surface debris.
3. Begin augering, periodically removing any accumulated sediment (i.e., cuttings) from the auger bucket. Cuttings should be disposed of far enough from the sampling area to minimize cross contamination of various depths.
4. After reaching the upper range of the desired depth, slowly and carefully remove bucket auger from the boring.
5. Attach the tube auger bit to the required lengths of extensions, then attach the "T" handle to the upper extension.
6. Carefully lower tube auger down borehole using care to avoid making contact with the borehole sides and, thus, cross contaminating the sample. Gradually force tube auger into sediment to the lower range of the desired sampling depth. Hammering of the tube auger to facilitate coring should be avoided as the vibrations may cause the boring walls

to collapse.

7. Remove tube auger from the borehole, again taking care to avoid making contact with the borehole sides and, thus, cross contaminating the sample.
8. Discard the top of core (approximately 1 inch); as this represents material collected by the tube auger before penetration to the layer of concern.
9. Transfer sample into an appropriate sample or homogenization container. Ensure that non-dedicated containers have been adequately decontaminated.

7.2.4 Sampling Surface Sediment with an Ekman or Ponar Dredge from Beneath a Shallow or Deep Aqueous Layer

For the purpose of this method, surface sediment is considered to range from 0 to six inches in depth. Collection of surface sediment can be accomplished with a system consisting of a remotely activated device (dredge) and a deployment system. This technique consists of lowering a sampling device (dredge) to the surface of the sediment by use of a rope, cable, or extended handle. The mechanism is activated, and the device entraps sediment in spring loaded or lever operated jaws.

An Ekman dredge is a lightweight sediment sampling device with spring activated jaws. It is used to collect moderately consolidated, fine textured sediment. The following procedure will be used for collecting sediment with an Ekman dredge (Figure 2, Appendix A):

1. Attach a sturdy nylon rope or stainless steel cable through the hole on the top of the bracket, or secure the extension handle to the bracket with machine bolts.
2. Attach springs to both sides of the jaws. Fix the jaws so that they are in open position by placing trip cables over the release studs. Ensure that the hinged doors on the dredge top are free to open.
3. Lower the sampler to a point 4 to 6 inches

above the sediment surface.

4. Drop the sampler to the sediment.
5. Trigger the jaw release mechanism by lowering a messenger down the line, or by depressing the button on the upper end of the extension handle.
6. Raise the sampler and slowly decant any free liquid through the top of the sampler. Care should be taken to retain the fine sediment fraction during this procedure.
7. Open the dredge jaws and transfer the sample into a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment grabs until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

A Ponar dredge is a heavyweight sediment sampling device with weighted jaws that are lever or spring activated. It is used to collect consolidated fine to coarse textured sediment. The following procedure will be used for collecting sediment with a Ponar dredge (Figure 3, Appendix A):

1. Attach a sturdy nylon rope or steel cable to the ring provided on top of the dredge.
2. Arrange the Ponar dredge with the jaws in the open position, setting the trip bar so the sampler remains open when lifted from the top. If the dredge is so equipped, place the spring loaded pin into the aligned holes in the trip bar.
3. Slowly lower the sampler to a point approximately two inches above the sediment.
4. Drop the sampler to the sediment. Slack on

the line will release the trip bar or spring loaded pin; pull up sharply on the line closing the dredge.

5. Raise the dredge to the surface and slowly decant any free liquid through the screens on top of the dredge. Care should be taken to retain the fine sediment fraction during this operation.
6. Open the dredge and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenized and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

7.2.5 Sampling Subsurface Sediment with a Coring Device from Beneath a Shallow Aqueous Layer

For purposes of this method, subsurface sediment is considered to range from 6 to 24 inches in depth and a shallow aqueous layer is considered to range from 0 to 24 inches in depth. Collection of subsurface sediment from beneath a shallow aqueous layer can be accomplished with a system consisting of a tube sampler, acetate tube, eggshell check valve, nosecone, extensions, and "T" handle, or drivehead. The use of additional extensions can increase the depth of water from which sediment can be collected from 24 inches to 10 feet or more. This sampler may be used with either a drive hammer for firm sediment, or a "T" handle for soft sediment. However, sample handling and manipulation increases in difficulty with increasing depth of water.

The following procedure describes the use of a sample coring device (Figure 4, Appendix A) used to collect subsurface sediments.

1. Assemble the coring device by inserting the acetate core into the sampling tube.

2. Insert the "egg shell" check valve into the lower end of the sampling tube with the convex surface positioned inside the acetate core.
3. Screw the nosecone onto the lower end of the sampling tube, securing the acetate tube and eggshell check valve.
4. Screw the handle onto the upper end of the sampling tube and add extension rods as needed.
5. Place the sampler in a perpendicular position on the sediment to be sampled.
6. If the "T" handle is used, place downward pressure on the device until the desired depth is reached. After the desired depth is reached, rotate the sampler to shear off the core at the bottom. Slowly withdraw the sampler from the sediment and proceed to Step 15.
7. If the drive hammer is selected, insert the tapered handle (drive head) of the drive hammer through the drive head.
8. Drive the sampler into the sediment to the desired depth.
9. Record the length of the tube that penetrated the sample material, and the number of blows required to obtain this depth.
10. Remove the drive hammer and fit the keyhole-like opening on the flat side of the hammer onto the drive head. In this position, the hammer serves as a handle for the sampler.
11. Rotate the sampler to shear off the core at the bottom.
12. Lower the sampler handle (hammer) until it just clears the two ear-like protrusions on the drive head, and rotate about 90°.
13. Slowly withdraw the sampler from the sediment. If the drivehead was used, pull the hammer upwards and dislodge the sampler from the sediment.

14. Carefully remove the coring device from the water.
15. Unscrew the nosecone and remove the eggshell check valve.
16. Slide the acetate core out of the sampler tube. Decant surface water, using care to retain the fine sediment fraction. If head space is present in the upper end, a hacksaw may be used to shear the acetate tube off at the sediment surface. The acetate core may then be capped at both ends. Indicate on the acetate tube the appropriate orientation of the sediment core using a waterproof marker. The sample may be used in this fashion, or the contents transferred to a sample or homogenization container.
17. Open the acetate tube and transfer the sediment to a stainless steel, plastic or other appropriate composition (e.g., Teflon) container. Ensure that non-dedicated containers have been adequately decontaminated. If necessary, continue to collect additional sediment until sufficient material has been secured to fulfill analytical requirements. Thoroughly homogenize and then transfer sediment to sample containers appropriate for the analyses requested. Samples for volatile organic analysis must be collected directly from the bucket before homogenization to minimize volatilization of contaminants.

8.0 CALCULATIONS

This section is not applicable to this SOP.

9.0 QUALITY ASSURANCE/ QUALITY CONTROL

There are no specific quality assurance (QA) activities which apply to the implementation of these procedures. However, the following QA procedures apply:

1. All data must be documented on field data sheets or within site logbooks.

2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation, and they must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY

When working with potentially hazardous materials, follow U.S. EPA/OSHA and Corporate health and safety procedures.

More specifically, when sampling sediment from waterbodies, physical hazards must be identified and adequate precautions must be taken to ensure the safety of the sampling team. The team member collecting the sample should not get too close to the edge of the waterbody, where bank failure may cause loss of balance. To prevent this, the person performing the sampling should be on a lifeline, and be wearing adequate protective equipment. If sampling from a vessel is determined to be necessary, appropriate protective measures must be implemented.

12.0 REFERENCES

Mason, B.J., Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

Barth, D.S. and B.J. Mason, Soil Sampling Quality Assurance User's Guide. 1984 EPA-600/4-84-043.

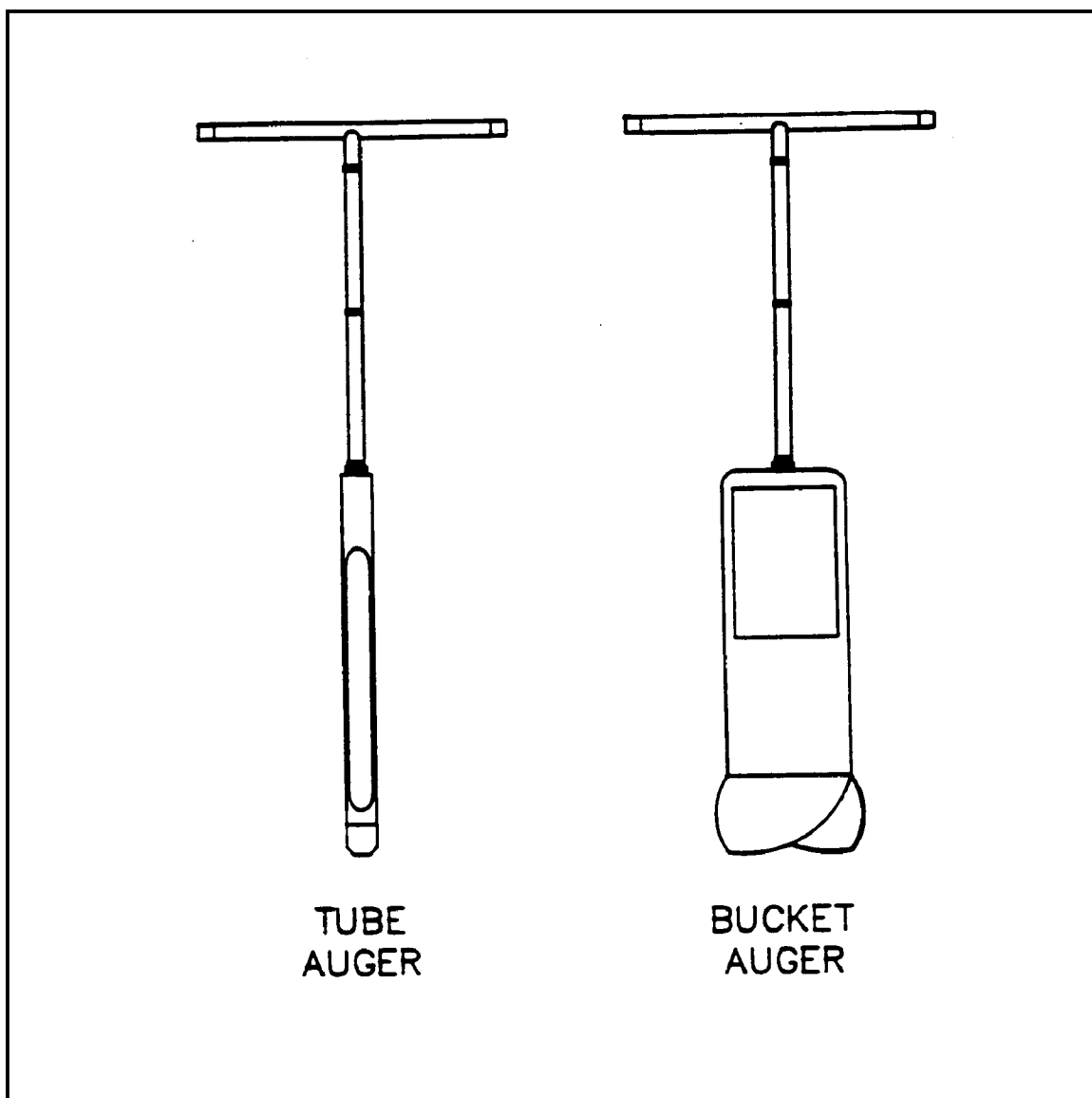
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APPENDIX A

Figures

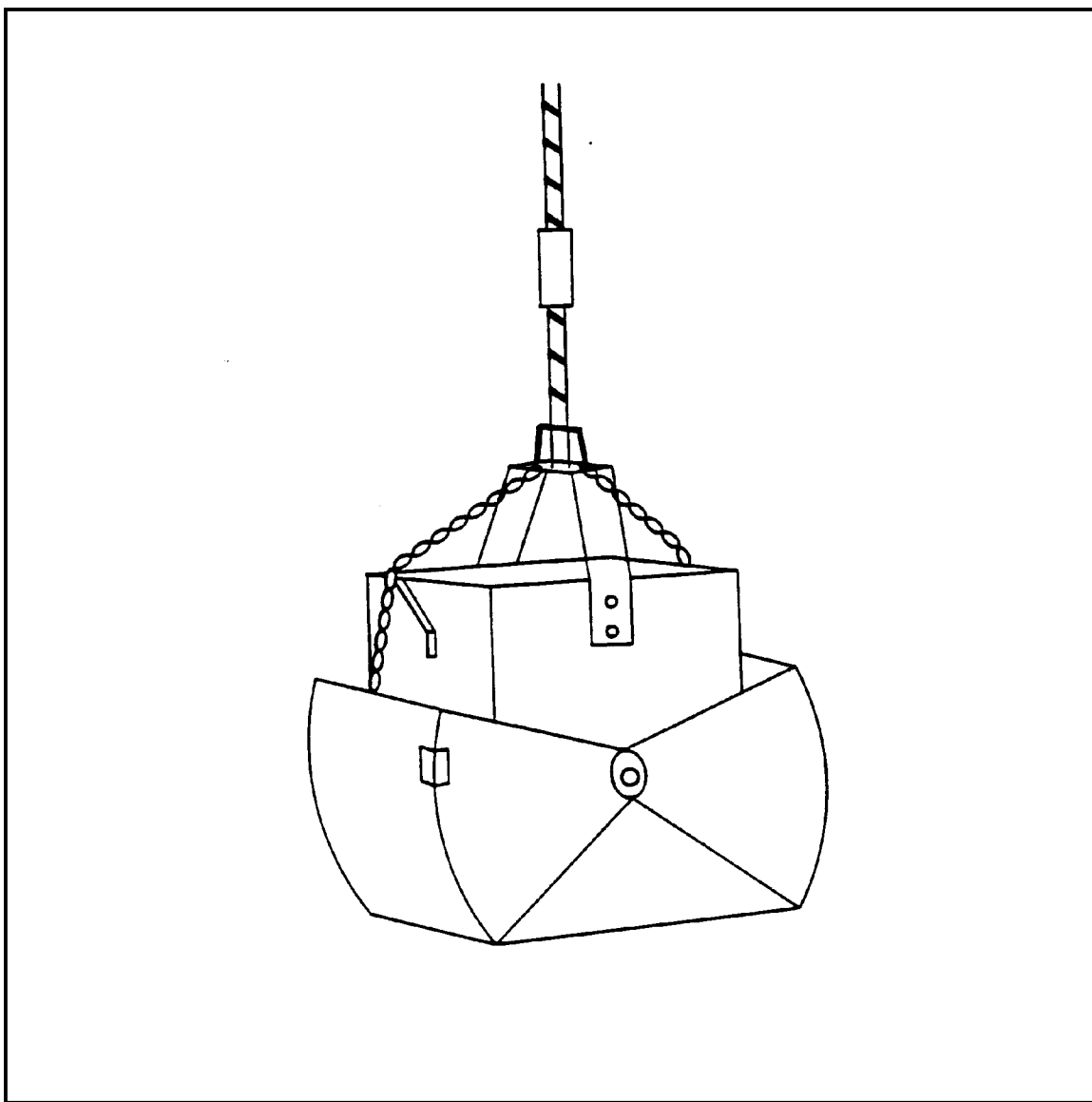
FIGURE 1. Sampling Auger



APPENDIX A (Cont'd)

Figures

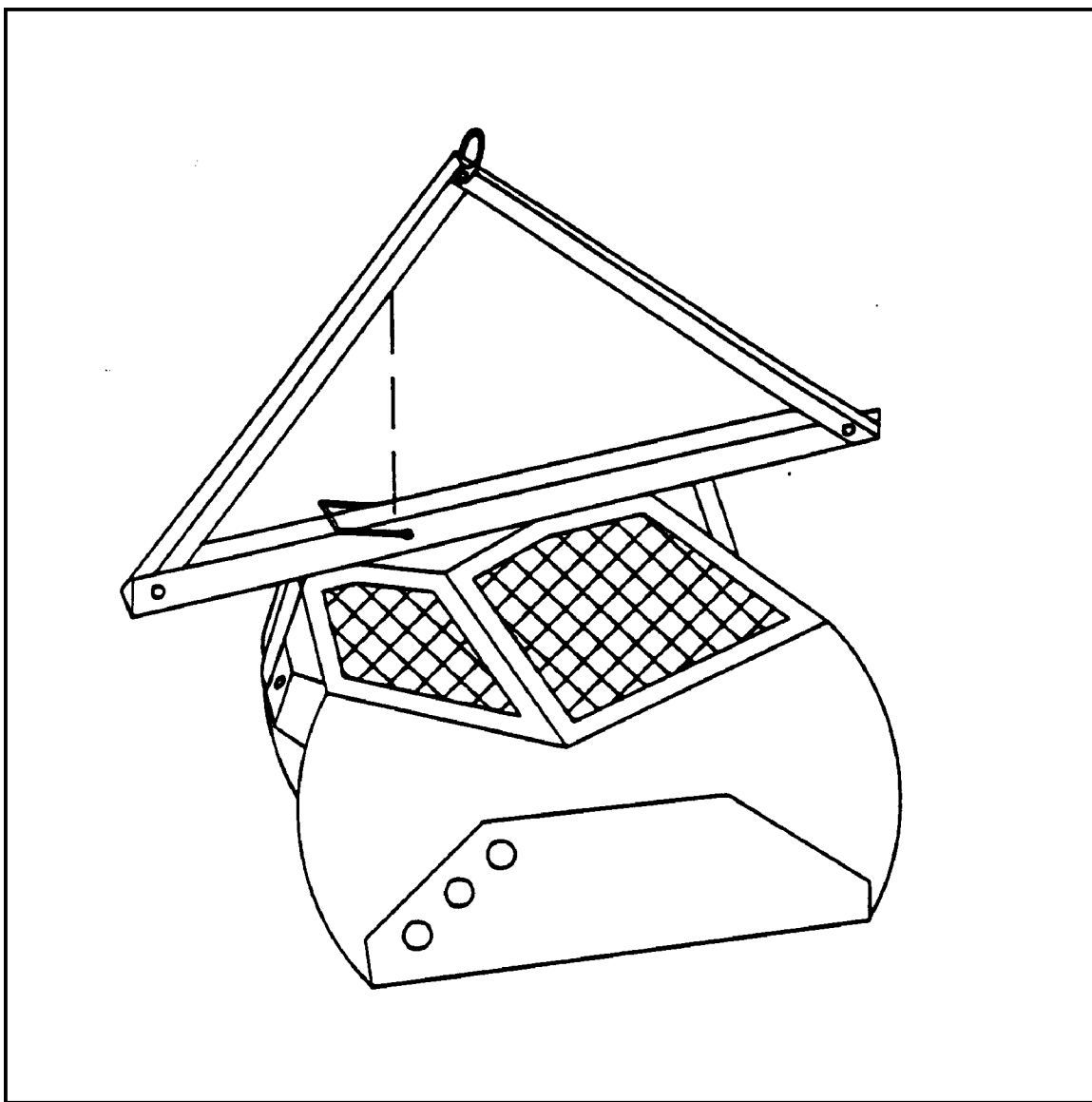
FIGURE 2. Ekman Dredge



APPENDIX A (Cont'd)

Figures

FIGURE 3. Ponar Dredge



APPENDIX A (Cont'd)

Figures

FIGURE 4. Sample Coring Device

